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The Outlook

Attack Aircraft

THE American Army has a section of its Air Forces to which it has given the title of "Attack," meaning that its business is to attack ground targets. The time seems to have come when the R.A.F. ought to recognise the existence of a similar class, and give it a distinctive name. At present this work is carried out (especially in Libya) by machines which are still designated as "fighters." We have all been reading official reports of late which tell of our fighter aircraft making low-level attacks on enemy tanks, armoured car and motorised units on the desert tracks to the south of Benghazi as well as on supply columns farther to the west.

The proper business of fighters is to engage other enemy aircraft for the protection of our own ground troops and positions, and to leave the sky clear for our bombers to do their work. "Ground-strafing" is a different class of work, and fighters are only turned on to it at times, either because there are no properly equipped "attack" class machines available, or because some of our fighters have been equipped for that work but have not been given a new designation.

In the great German offensive of March, 1918, the R.A.F. fighters in France were extensively employed in ground-strafing, but it is doubtful whether the tactics were wise. The upper air was left open for enemy bombers (though they missed the opportunity to use it), while the losses of our own fighter machines and pilots were heavy. The Sopwith Salamander, which was specially designed for ground-strafing, was not produced in time to have much effect.

Modern fighters are armoured, and when fitted with shell-guns can do much damage to ground targets. The bombs which certain Hurricanes carry can also be used for that work. But it is misleading to call these machines "fighters." They are "attack" aircraft (though, perhaps, a better name could be thought of for the class) and their work is quite different from that of fighters. The commander who uses his fighters overmuch for attack work runs the risk of losing the command of the air.

Studying Enemy Aircraft

DURING the war 1914-18 such captured types of enemy aircraft as were sufficiently intact to make a study of their design and construction profitable were collected at the Agricultural Hall, Islington, London, where they were on view to members of the British aircraft industry and of the fighting forces. The method of showing the machines was the best ever evolved. The aircraft were stripped on one side, up to the centre line, and left covered on the other. In that way one could form an opinion of the external shapes and the degree of streamlining (such as it was in those days) by looking at the aircraft from one viewpoint, while by walking across to the other side every detail of the structure could be examined with a minimum of trouble.

It very quickly became the custom for *Flight* to send representatives to this exhibition for the purpose of illustrating and describing the German machines. Even when the Air Ministry instituted its own department to deal with captured German aircraft, we were still permitted to pay our regular calls at the Agricultural Hall, and many were the letters which we received from the aircraft industry thanking us for the information thus

placed in the hands of all interested, from the chief designer to the most junior draughtsman.

In this war things have been different. The technical Press was, it is true, permitted to visit air stations where German aircraft were on view, but the time allowed was much too short to enable a really detailed examination to be made. Representations made to the Ministry of Aircraft Production met with scant encouragement, and it was not until Lt. Col. Moore-Brabazon assumed control at Millbank that we made any headway. Now, as our readers will know, we have been granted permission to publish reports on certain German types. Last week we dealt with the Messerschmitts, and this week we describe the modified Junkers Ju 88 A-6, which has a larger wing span than the earlier models and certain alterations in equipment. We have been promised similar reports on other types.

While we welcome the assistance thus granted us, because in the ordinary way official reports issued to the aircraft industry rarely get beyond the chief designer and the chief draughtsman, we do feel that more might have been done in the way of arranging exhibitions in London and the provinces. No printed report, no matter how well done, can quite take the place of personal inspection, and if representative types of captured German aircraft had been exhibited as soon as possible, the more junior members of the industry and of the R.A.F. would have benefited materially. It is now rather late in the day; but, in view of the fact that German design policy does not change very rapidly, the idea might still have merits. We offer it for consideration in the right quarters.

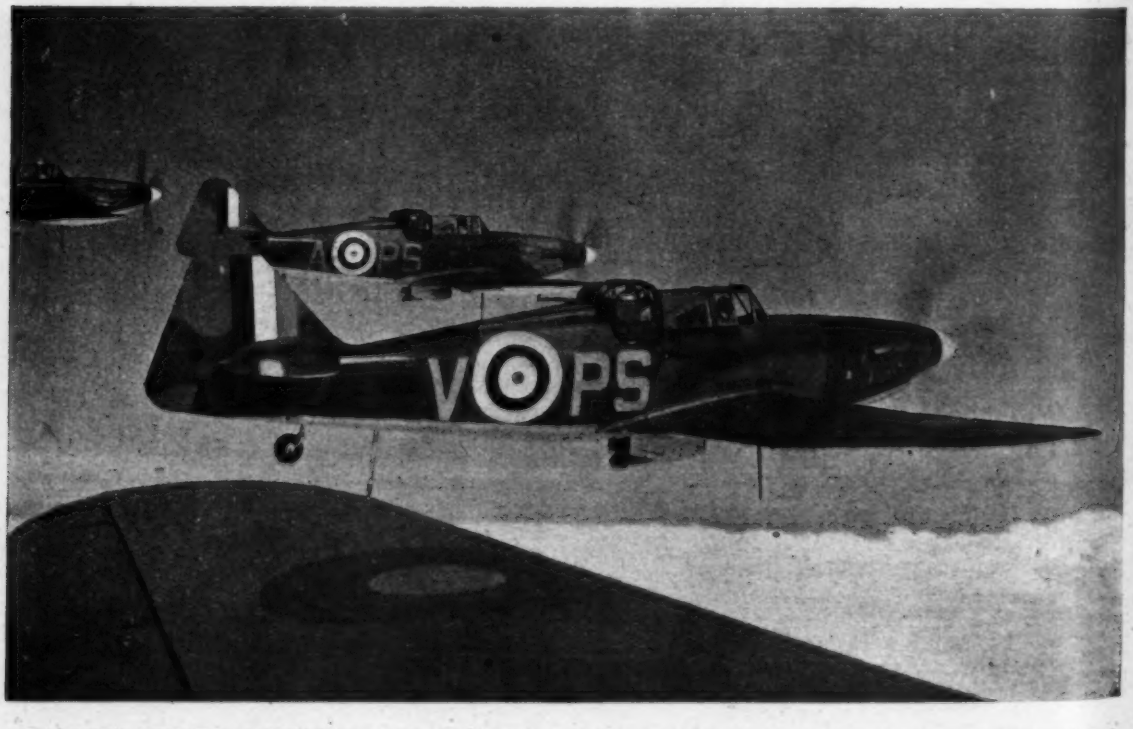
"Cutting-out"

A SENTENCE in the report on the handling characteristics of the Messerschmitt Me 109E, published in our issue of last week, once more draws attention to a subject with which we have dealt on several occasions:

> "The direct-injection engine does not cut-out or splutter under negative 'g,' as when diving suddenly to seek shelter in cloud."

It is now considerably more than a year ago that *Flight* began to advocate that steps should be taken to get rid of this unpleasant habit of the ordinary carburettor-fed aircraft engine. To change over to direct injection in the middle of a huge production programme may not be feasible, but it is known that in the United States the Bendix-Stromberg system has been used with satisfactory results for a number of years, and the rapid adoption of this half-way measure should not present insuperable difficulties, nor should it cause serious delays. We still hear fighter pilots lamenting the fact that this cutting-out often results in their missing a Hun who would otherwise have been "in the bag." Although the subject is being tackled, it appears that an energetic speeding-up is needed. The comparative immunity which these islands have enjoyed for many months should have given ample opportunity for the problem to have been solved by now.

WELL NAMED



A FIGHTER WHICH IS DIFFERENT: A flight of Boulton Paul Defiants out looking for trouble. The unusual feature of the type is that all four guns are concentrated in the 'midship turret. These particular machines are painted in day-fighter colours, but more recently the type has been used as a night-fighter. An illustrated description appears on pp. 132-135 of this issue.

War in the Air

A Junkers Ju 88 brought down by the A.A. guns of the Soviet Navy in the Barents Sea.

R.A.F. Gives Axis Forces No Respite in Libya : Naval Aircraft Attack Rommel's Supply Ships : Japanese Suffer Heavy Losses in S.W. Pacific

WITH the heartening exception of the Red Army's continued progress against the German invaders, the news has not been any too cheering during the past week.

Since these notes last appeared, Derna has fallen and, at the time of going to press, there seems little indication that Rommel's drive is either exhausting itself or being checked. The man in the street may well be excused if he is as much puzzled as dismayed by the continued advance of the Axis forces in this theatre of the war. Has he not been told, time and again, that success goes to the side which commands supremacy in the air? And has he not also been told that the R.A.F. has achieved this necessary supremacy over the Western Desert?

Actual news from Libya has been scarce of late, and war correspondents have tried to make up for its scarcity, and the unfavourable nature of what bit there has been, by reminding the public that our object in that area is not so much to gain territory as to destroy the Axis forces. So far, however, it would appear that the wily Rommel has been getting reinforcements in men and materials very much faster than we have been able to destroy them, in spite of the high rate of wastage which the Royal Navy, Fleet Air Arm and the R.A.F. have been causing him.

Nevertheless, in the Msus district, farther south, British forces appear to have fared better, though whether this is due to a greater concentration of strength on our part, or rather less offensiveness by Rommel, is not indicated by the official communiqués.

The one gleam of hope in the situation, as it appears at the moment, is the assurance that our losses in men are not heavy and that continued operations of our aircraft over the whole area are inflicting substantial losses upon the enemy. This has even led to the suggestion by some amateur students of the war that our retreat in a north-easterly direction may be a trick to lure Rommel's army away from country favouring his defence into terrain in which its destruction will be easier to accomplish. But it has to be admitted that this sounds only too much like a thought fathered by a wish. To retreat to victory would certainly be something quite new in fighting technique.

Non-stop Air Attacks

CERTAIN it is, however, that the R.A.F. is giving the Axis forces no respite, and while it is impossible to give anything like a complete picture of their activities, one may quote a series of incidents from recent official reports as indicative of the sort of punishment being continuously inflicted upon the enemy by our airmen.

Enemy motorised units moving along the Ghemines-Benghazi road and in the Elk Harruba and Msus areas of Western Cyrenaica were effectively machine-gunned by our fighter aircraft during Saturday, January 31st. A number of trucks and other vehicles were destroyed, and casualties were inflicted on enemy personnel as they made for cover.

During the night of Friday, January 30th-31st, bomber aircraft raided motor transport and encampments between Jedabya and El Agheila, fires and explosions being observed. Our aircraft also machine-gunned the vehicles and tents from a low level.

Other bomber aircraft were active over Tripolitania. At Tripoli, where the Spanish Mole and motor transport parks south of the town were bombed, a large fire, accompanied by many explosions, broke out. Motor traffic and barrack buildings between Misurata and Zlitene were also attacked.

In the Central Mediterranean, naval aircraft, operating in bad weather, scored hits with torpedoes on two merchant vessels. The first ship, which was struck by one torpedo, was last seen at a standstill with a list to port. The second vessel was

LEASE AND LEND: Captain Naidenko, of the U.S.S.R. Air Force, briefing the pilots of his Tomahawk squadron.

hit by two, and probably three, torpedoes, and when our aircraft left was down by the stern with a starboard list and smoke pouring from it.

One large and one medium-sized merchant ship on their way to North Africa with valuable supplies for the Axis forces were probably sunk by Naval torpedo-bombers in the Central Mediterranean on Friday night. On the previous night, the same pilots had torpedoed a fully laden oil tanker. The larger of the two merchant ships was last seen hove-to, listing to starboard, down by the stern with smoke billowing from below decks.

The second ship, which was of medium size. had also stopped, and was listing to port after the attack. The Sub-Lieutenant, who opened the attack on the larger ship, said that after his torpedo struck the vessel clouds of smoke and steam came from it. Two more pilots quickly followed up this attack. A Sub-Lieutenant scored a hit amidships and saw the merchantman settling down by the stern.

There was a rough sea running in the area where the smaller vessel was located. To make sure of the target, our pilots came down to less than 30ft. from the water to release their torpedoes. The ship stopped immediately and began to list to port. The pilots engaged on the raids believe that neither vessel could have stayed afloat for long.

Attack on Singapore

FARTHER east, at Singapore, the position is somewhat clearer though giving even greater cause for concern, for it is evident that the fate of this important base depends on whether the substantial Allied reinforcements on their way can reach the defenders before the Japanese forces concentrating in Johore on the opposite side of the narrow straits can bring off a successful attack.

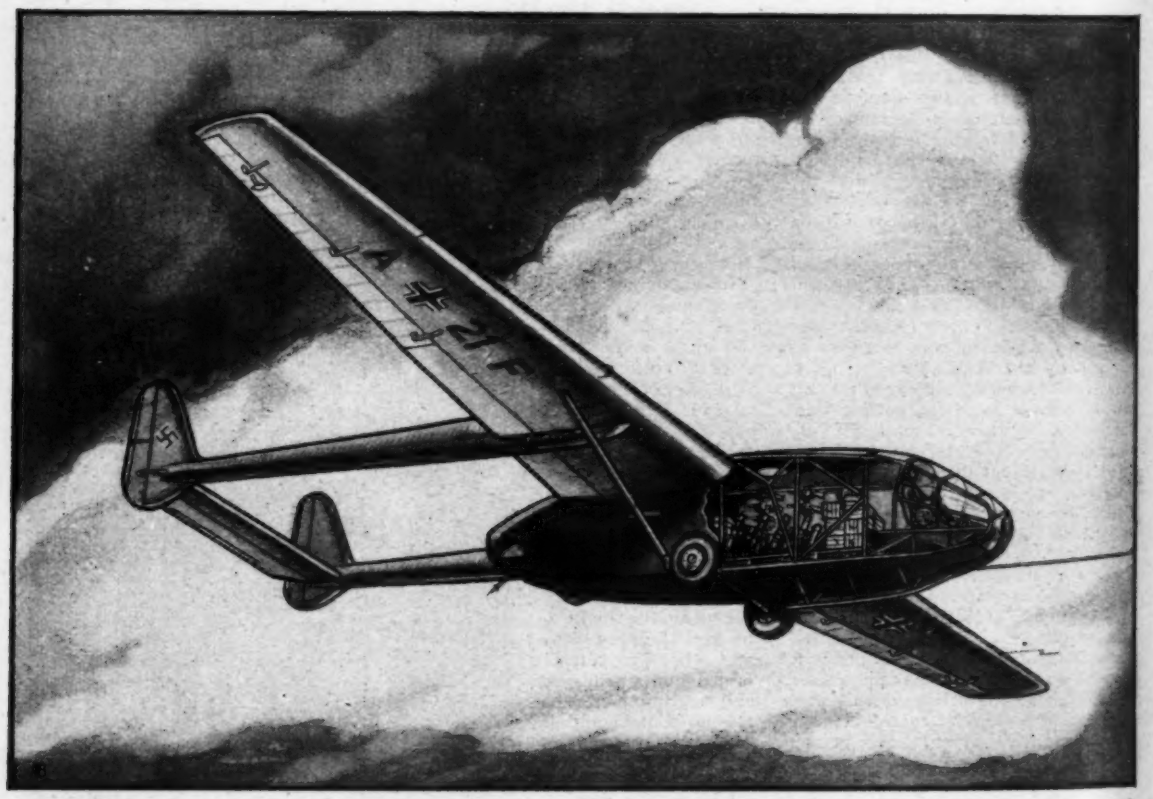
By the time these words reach the reader, the race between the Allied reinforcements and the Japanese preparations for invasion of Singapore island may well have been won and lost. Indeed, a landing on the west side of the island has already been reported, following artillery duels across the intervening water and increasingly heavy air raids, most of which have been high-level attacks.

It is at least a matter for some satisfaction—not to say consolation—that these raids, which have been growing in intensity since the last of our troops withdrew from Johore, are costing the enemy a high price in both machines and aircrews. Not only have the beleaguered island's Ack-Ack guns put up some most effective shoots, but British Hurricanes have made such exploits increasingly expensive by vigorous interception over the Malayan mainland.

Blenheim bombers, escorted by American fighters, have also attacked the Nippon invaders in Burma, and some figures for January have just been issued based on communiqués from Singapore, Rangoon and Melbourne. These show that, although the information given is probably not complete, the R.A.F. and R.A.A.F. in the South-West Pacific Command have, during the month, carried out a total of 43 bombing attacks against 23 land targets, many of which have been airfields occupied by the enemy.

January's Far East "Bag"

IN all defensive and offensive air operations carried out by the R.A.F., the American Volunteer



A German twin-boom glider, reconstructed by a *Flight* artist from a photograph of a wrecked specimen left on an airfield in Libya. Of roughly 70ft. span, it should be capable of lifting some 6,000-7,000 lb. The twin-boom arrangement keeps the lifting and control surfaces entirely separate from the body and is probably used in order that specialised carrying containers can be employed for any particular work in hand. It is shown here carrying 3in. mortars and tommy guns, but it is easy to visualise other containers designed to carry men, artillery or supplies. The wheels are jettisoned after take off and a skid landing made.

E AIR

ENEMY AIR LOSSES TO FEB. 7th.

		Over G.B.	Over Continent	Middle East	Far East
Feb.	1	0	0	0	10
"	2	1	1	1	0
"	3	0	0	0	0
"	4	0	0	0	0
"	5	1	0	1	3
"	6	0	0	2	15
"	7	0	1	1	7
		2	2	5	35

Totals: North, 5,623; Middle East, over 3,457; Far East, 191.

Group in co-operation with the R.A.F at Rangoon, and the R.A.A.F., in the Far East, a total of 213 aircraft have been destroyed in air combat, by A.A fire, and on the ground. Of these enemy casualties, 113 were inflicted in the Singapore area, 80 in the Rangoon area, 13 by aircraft under S.W. Pacific Command, and seven by the R.A.A.F. In addition, further losses have been inflicted on the enemy by U.S.A. and Netherlands East Indies Air Forces, precise details of which are not, as yet, available.

The Allied air offensive against enemy shipping in the Far East is also gathering momentum, with the result

BRITISH AIR LOSSES TO FEB. 7th.

		Over G.B. A'crft.	Over Continent B'brs.	Over Continent Ftrs.	Middle East A'crft.	Far East A'crft.
Feb.	1	0	0	0	0	1
"	2	0	2	1	0	0
"	3	0	0	0	0	0
"	4	0	0	0	0	0
"	5	0	0	0	0	0
"	6	0	2	0	0	1
"	7	0	3	0	4	0
		0	*7	1	12	2

Totals: North 3,208; Middle East about 933; Far East 21.

WILD GOOSE CHASE: A Japanese Army Karigane (Wild Goose) on reconnaissance.

that, during January, no fewer than 52 Japanese ships of all types, including five cruisers, two destroyers and a number of supply ships, tankers and transports, have been sunk or severely damaged. An outstanding series of attacks was made against an enemy convoy in the Macassar Straits by N.E.I. and U.S.A. aircraft, and it is conservatively estimated that some 20 ships were either sunk or damaged here in spite of heavy naval protection, but complete results of these attacks have not, at the moment of writing, been ascertained, and it may eventually transpire that even greater damage was inflicted on this convoy.

The U.K. Front

MEANWHILE, over home waters, the ceaseless vigilance of the R.A.F. has continued, aided in many cases by units of Allied airmen based in this country. Beauforts of Coastal Command have attacked enemy shipping along the enemy's extensive shores, and Bomber Command have, in spite of wicked weather conditions, patrolled over the North Sea and dutifully visited the docks at Brest.

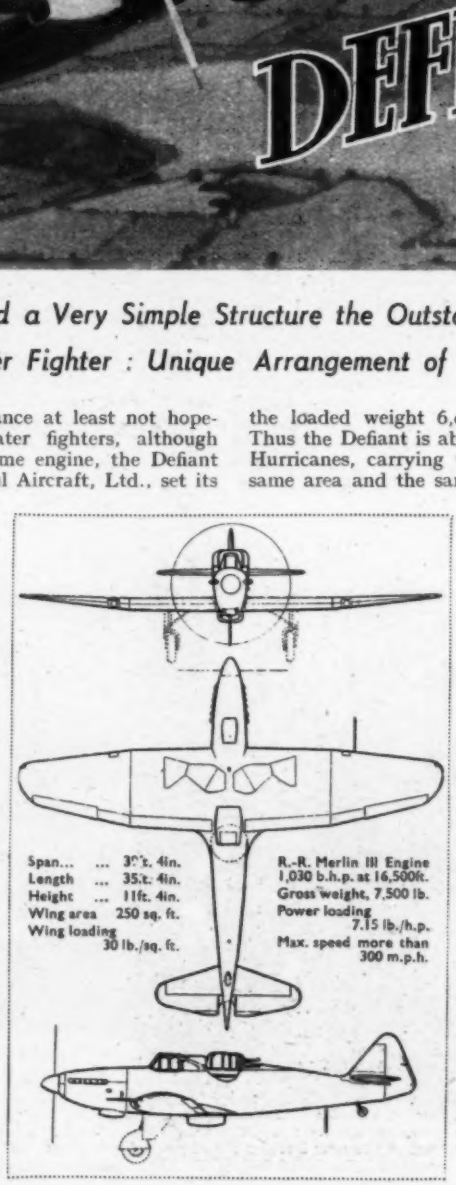
Air attacks on this country have been limited to isolated "tip and run" assaults on coastal places, damage and casualties being very slight.

LUFTWAFFE'S LATEST. One of several of the new Dornier Do 217e bombers which have been brought down over England recently. Particulars of the Do 217e appear on page f.

"Split" Construction and a Very Simple Structure the Outstanding Features of this Two-seater Fighter : Unique Arrangement of Armament

INTENDED to have a performance at least not hopelessly outclassed by single-seater fighters, although being a two-seater with the same engine, the Defiant designed and built by Boulton Paul Aircraft, Ltd., set its designers a great number of problems. The very fact that two people had to be carried meant that the machine must be heavier than the single-seater fighter, yet it was essential that it should be not only fast but also very manœuvrable, otherwise its usefulness as a fighter would be seriously restricted. Furthermore, the machine was designed around an entirely new conception of armament arrangement. Instead of the usual two fixed guns for the pilot and two mobile guns in the rear cockpit, all four guns were to be located in a power-operated turret amidships. It will be obvious that the very presence of such a turret, apart from the weight, must add considerably to the drag.

A few figures will help further to illustrate factually the solution of the design problems. Taking for purposes of comparison the Mark I Hurricane single-seater fighter with the same Rolls-Royce Merlin III engine of 1,030 h.p., the wing span of the Hurricane is 40ft., that of the Defiant 39ft. 4in. The two wing areas are 257 sq. ft. and 250 sq. ft. respectively, and the loaded weight 6,000 lb. and 7,500 lb. respectively. Thus the Defiant is about 1,500 lb. heavier than the early Hurricanes, carrying the extra weight on practically the same area and the same span. The speed of the Mark I Hurricane was about 330 m.p.h. That of the Defiant may not be published, but it is claimed to be "more than 300 m.p.h."


Span... ... 39ft. 4in.
Length ... 35ft. 4in.
Height ... 11ft. 4in.
Wing area 250 sq. ft.
Wing loading 30 lb./sq. ft.
R.-R. Merlin III Engine 1,030 b.h.p. at 16,500ft.
Gross weight, 7,500 lb.
Power loading 7.15 lb./h.p.
Max. speed more than 300 m.p.h.

From the military point of view the really interesting thing about the Defiant is its unusual armament concentration in a single power-operated gun turret. It will be readily appreciated that this placing of the machine guns meant that new tactics had to be schemed out before the Defiant could be used to best advantage. No longer could the pilot aim his machine at the enemy, fire a burst at him and then turn to give his rear gunner a chance. He had to think in terms of the gunner from the start, and it is scarcely surprising that it took some little time to evolve the new technique. When it had once been worked out it proved highly successful, and in one day over Dunkirk a squadron of Defiants accounted for 37 enemy aircraft. That surprise caused by the new tactics played an important part is not to be doubted.

In general layout the Defiant conforms to the now familiar single-engined tractor, low-wing

monoplane formula, and the cupola of the four-gun turret —mounted on the upper surface of the fuselage just over the wing trailing-edge—is the only obvious indication that the machine has any unusual characteristics.

To obtain the required performance, the designers of the Defiant had to keep the aerodynamic design as clean as possible. That meant very careful streamlining, and yet considerations of easy production demanded simplicity of outline, with a minimum of forming of the sheet-metal covering As in every aircraft, a compromise had to be made, and that it was successful is proved by the clean appearance which, as will be indicated presently, is coupled with a remarkably simple structure.

Sheet Forming Avoided

Although the fuselage appears to be a perfect streamline shape, it is actually composed, apart from the engine cowling and a small portion at the tail, of two cones joined by a short transition section about 2ft. long. The two cones, containing no "double" curvatures, can be formed by wrapping the skin covering around the framework. The transition section requires a small amount of forming. Similarly in the wings, the taper, which aerodynamically approaches the elliptical plan form which is known to give the lowest induced drag, is composed of two linear tapers, one slight one on the centre section, and a more pronounced taper on the outer wing portion. The extensive use of these so-called "developable" surfaces (a horrible word) makes it possible to avoid almost entirely those unsightly small buckles and ripples which can so easily disfigure an otherwise attractive-looking aircraft.

The front end of the fuselage is built as a unit, on four angle-section longerons of extruded light alloy. At the extreme front of this unit is a braced tubular frame carrying the attachments for the engine mounting. The two lower longerons are bent to conform to the contour of the upper surface of the wing centre section, which fits into the concave recess thus formed in the bottom of the fuselage. The four longerons are connected by side-members built up of light alloy sheet or strip, shaped to the body cross-section—which is ovoid—at the sides, and by tubular or box-section horizontal members up to the rear of the recess into which the wings fit, where complete bulkheads shaped to the fuselage section—except that they are flat topped—are employed.

The two side frames of this fuselage unit are tied together by a second tubular frame over the rear spar of the wing centre section, and by horizontal decks of corrugated light alloy sheet, supported on horizontal struts.

The rear section of the fuselage is built in three units—two side-members and a deck. The two side-members are identical except that they are handed. Each is built on two angle section longerons of extruded light alloy, coupled by a series of formers resembling, in many ways, a wing rib. The fuselage "ribs" comprise a channel section boom bent to the contour of the cross-section of the fuselage, tied across its ends by a straight tubular strut, with diagonal bracing tubes between the "boom" and the chord tube. There are five such "ribs" along the length of each side, and in addition there are intermediate formers —which are practically duplicates of the rib "booms" without any bracing tubes. The rear ends of the side sections each have built-up diaphragms of light alloy sheet in place of an end rib.

For ease of manufacture and assembly the rear fuselage of the Defiant is split into three parts: two sides and a top. Joints are made on the single bottom and two top longerons. The Z-section stringers lie between the skin and the rings.

Riveting "On the Flat"

The front end of these sections is open, to fit on to the rear frame of the front unit of the body on assembly. The covering sheets—after being riveted on the flat to a series of standard "Z" section stringers—are wrapped round the frame, and the stringers are riveted to the "ribs" and skeleton formers. The longitudinal edges of the skin, however, are riveted directly to the longerons, and the rear edge of the skin is riveted to the rear diaphragm. The third member of the fuselage—the deck—is a strip of corrugated light alloy sheet, with corrugations running at right angles to the length of the fuselage, stiffened by three longitudinal stringer members.

The rear fuselage unit is assembled by bolting the bottom longerons of the two side units together, and bolting the deck panel to the two top longerons. This fuselage construction makes it possible to assemble such details as control fairleads and guides, etc., in the units of which the body is composed before the units are assembled and whilst they are easily accessible from both sides.

The wings of the Defiant, like the fuselage, comprise a series of unit assemblies—one centre section and two outer wings, plus two detachable wing tips.

In the wing construction the stringers are cut at the ribs, to which they are attached by brackets. The simplicity of the structure is well brought out in this picture.

BOULTON PAUL DEFIANT

Both the centre section and outer wings are built on two spars. These spars comprise top and bottom booms of extruded light alloy, joined by vertically corrugated webs. The centre section spar booms are of "T" section; those for the outers are angle sections. The lower booms of the centre section spars are bent at the centre to provide for the appreciable taper in wing thickness; all other booms are straight.

The centre section wing houses at its outboard ends the two petrol tanks, and inboard of these carries and provides housing for the undercarriage, which retracts sideways. As a result the number of full-depth ribs which can be provided between spars in the wing centre section is limited to one at each outer end, one inboard of the tank compartment (serving to carry the undercarriage) and one on the centre line of the aircraft. The undercarriage "rib" is a very stiff beam which is skewed relative to the line of flight, the remaining ribs being of the usual girder type.

Centre-section Structure

As the bottom skin of the centre section is necessarily incomplete to allow for retracting the undercarriage, to permit of the removal and replacing of tanks, and for access to equipment in the wing, the combination of two spars and of such skin as is present does not produce a complete box structure.

The centre section unit is completed by a leading edge—whose skin is continuous from spar boom to spar boom—which forms, with the spar, a "D" section tube, and by a trailing-edge portion, which includes an auxiliary spar with a stiff corrugated web about half-way between the rear spar and the trailing edge. This auxiliary spar, plus the top and bottom covering skin, and the main rear spar, effectively produce a box rear spar, and the resulting centre section in the complete form is an extremely strong and rigid structure in consequence. In the outer sections, top and bottom skins are continuous between front and rear spars, so that here there is an effective box beam. In addition, the leading edge and the front spar form together a continuous "D" section tube as in the case of the centre section, thus still further strengthening the structure.

The leading edge for both centre and outer wings is detachable. It consists of a sheet of light alloy bent to the correct profile, riveted to a series of nose rib formers.

The joints of the spars between outer and centre section spars are provided by machined steel fittings attached to the spar booms which accommodate ground taper bolts. There is a definite gap between the outer and the centre sections when assembled. This gap is closed by screws at the trailing edge.

Tail Construction

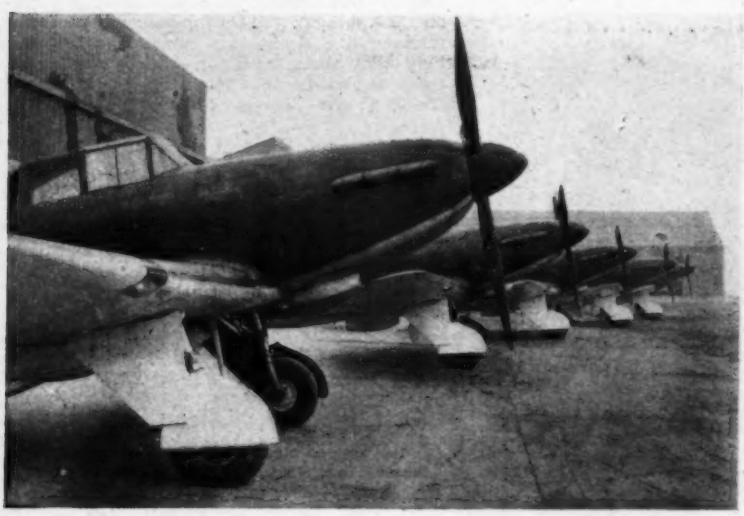
The tailplane and the fin are unbraced metal-covered structures, each built on a series of tapered longerons, covered with flush riveted covering. Ailerons, elevators and rudders are metal-framed structures, fabric covered.

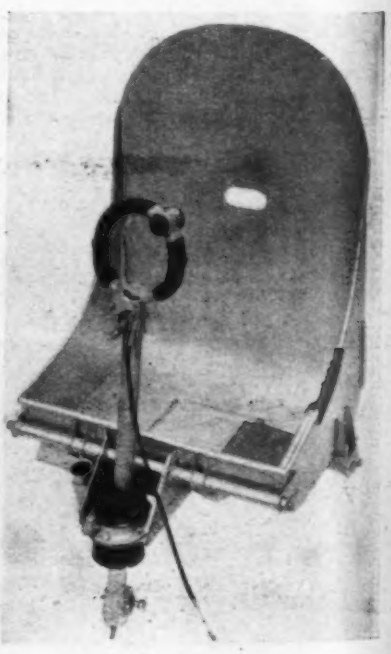
The elevators and rudders are provided with trimming tabs, adjustable from the cockpit, those of the rudder having in addition some automatic servo action. It is of interest to note that the two elevators are identical, i.e., are not right and left hand. To secure this, elevator and tab control connections are on the top of one elevator and on the bottom of the other.

The undercarriage comprises two Lockheed "Airdraulic" shock-absorber legs hinged to the diagonal beams already mentioned as among the few complete "ribs" on the wing centre section. Each leg is retracted or extended by a "break-back" strut which extends diagonally inwards towards the fuselage and rearwards towards the rear spar. When completely retracted, the undercarriage lies completely within the contour of the centre section, with the tyres of the two wheels nearly meeting on the centre line of the aircraft. The opening in the centre section into which the undercarriage retracts is completely closed, in flying condition, by two flaps carried from each undercarriage leg (which two flaps, between them, cover the openings up to the wheel centre) and by two semi-circular flaps hinged to the central rib of the centre section. The latter project vertically downwards whilst the undercarriage is extended, but are closed, when the under-

(*Continued on page* 135.)

A line-up of Defiants, ready for delivery. These particular machines are day-fighters, but the type is also extensively used as a night-fighter. The engine is a Merlin III, driving a de Havilland constant-speed airscrew. (Right) The neat arrangement by which the control rises and falls with the adjustable seat so that the control handle is always in the same relative position.





Twenty-fifth of the Second Series

FRIEND or FOE?

British and Italian Transports : Bristol Bombay and Caproni 133

BRISTOL BOMBAY. Palette shaped twin fins and rudders set well inboard from tailplane tips. Straight, parallel-edged tailplane braced by single struts. Shorter leading-edge, rather square tips. Stinger gun-turret. Fixed landing gear.

FIXED undercarriages are so few and far between to-day, especially among the larger multi-engined types of military aircraft, that they whittle down the field of possibilities very considerably when a spotter sees one in the distance. The most common example among fixed undercarriages is, of course, the Lysander—a machine which even maiden aunts can recognise at sight—but if the approaching aircraft is seen to possess two engines plus depending wheels, there is at least an even chance of its proving, on closer acquaintance, to be a Bristol Bombay.

That is reasonably true, at any rate, of this part of the world, but further East, in the vicinity of the Mediterranean for example, one would first have to make quite sure that the unknown machine did not possess three engines, because if it did, then it might be (among other things) a Caproni 133 transport. And from a rearward view it is by no means easy to differentiate between the two- and three-motored aircraft, as is made clear by the illustrations on this page.

Big Difference

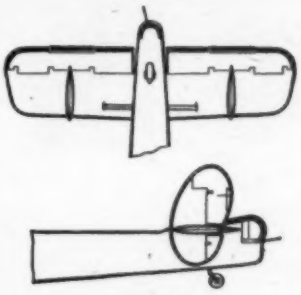
In the case of the Bombay and the Caproni 133, however, there is a big difference in their tails, which makes identification a simple matter, for the bigger British aircraft is of the twin fin and rudder type, whereas the Italian machine has a single tail unit. Moreover, each is fairly distinctive in its own class.

Taking first the Bombay, it will be seen from the accompanying drawings that its fins and rudders are almost palette shape and are set well inboard, with the tailplane intersecting at the level of the "thumb-hold," and the unbroken curve of the leading-edge projecting slightly in front of the tailplane's leading-edge. In other words, the horizontal surfaces are threaded through the vertical ones, the elevators projecting clear of the rudders.

The tailplane is of high aspect-ratio, has parallel edges and is braced by a single strut on each side. The tips shelve outwards towards the rear (the leading-edge being the shorter of the two), and the corners are rounded off.

From a side view it will be seen that the "stinger" gun turret projects well clear of the tail unit and commands an excellent field of fire.

BOMBAY

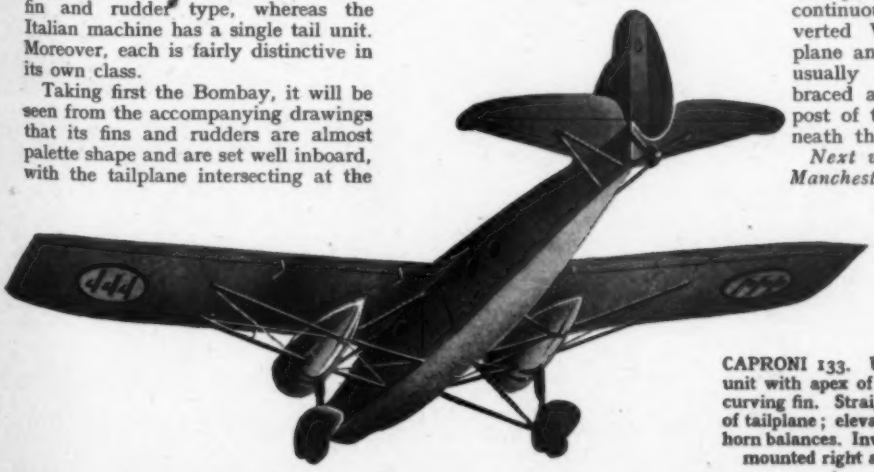


Ca 133

Unusual Outline

The Caproni's tail unit is most unusual in outline and may almost be accused of being "pretty pretty." The large area fin sweeps up in a double curve, but the round apex of the oval rudder projects well above it, imparting a curious wavy effect to the outline as a whole. The tailplane has a straight backsweep to its leading-edge, but the elevators, which project round the tips to form horn balances, have a continuously curving outline. Inverted V struts support the tailplane and the fixed tailwheel is unusually placed, being mounted on braced arms anchored to the stern-post of the fuselage immediately beneath the rudder.

Next week: The Whitley and the Manchester.



CAPRONI 133. Unusually "pretty" single tail unit with apex of oval rudder projecting above curving fin. Straight backsweep to leading-edge of tailplane; elevators curving round tips to form horn balances. Inverted V struts. Fixed tailwheel mounted right aft on stern-post of fuselage.

HERALDRY IN THE AIR

(Above) "Goofy" throws the bombs of 12 successful raids by a Wellington.

(Below) Disney's mosquito operating an insecticide gun loaded with bombs is this Wellington pilot's motif.

(Above) "Wimpey." A favourite with all those who go for nocturnal prowls on Wellingtons.

(Below) A pilot officer of an American Eagle Squadron favours poker dice showing a straight flush on his cannon-armed Spitfire V.

(Above) Friar Tuck wielding his quarter-staff is the pictorial choice of a D.F.C. Wing Commander of a Halifax Squadron.

(Centre) A Halifax pilot hailing from Australia prefers a representation of his marsupial national emblem carrying missiles in the mammary pouch.

(Right) Fire bomb Fritz goes nightly over the Continent to return the compliment.

(Above) An old time "Peeler" arrests a puppet Goering. The Swastika in the top corner is for a Messerschmitt shot down during a daylight raid on Brest.

(Right) A Victory V surmounted by the Torch of Freedom done in the best heraldic style. Each bomb represents a raid over enemy territory.

(Above) A blood-covered German swastika, supported by Hitler and three vipers, receives the concentrated effort of the R.A.F. In the background the German sun, in the form of a bad penny, is seen setting over a horizon of flames.

(Below) Flight Lieutenant Donald Duck, this time of Coastal Command, takes a two-handed swipe at a U-boat.

(Above) A British Bulldog on a Union Jack tears a Nazi emblem to pieces.

(Above) Donald Duck, with all his usual verve, does a little bombing of his own.

Individual Pilots Show Wide Range in Choice of Decoration for Their Aircraft. Motifs of Distinct Humorous, Heraldic and Artistic Quality Fly Side by Side by Day and Night

EVERY week the R.A.F. is adding to its own peculiar heraldry. The devices painted on aircraft range from plain bombs to elaborate Victory V's, from British Bulldogs to Walt Disney and other film cartoon characters. Donald Duck grasping a bomb is favoured by several bomber crews whose aircraft letter is "D." Wellington bombers are known affectionately as Wimpeys so it is natural that quite a number carry Pop-eye's seedy looking companion as their sign. Broken swastikas, plump Goerings put to flight, Hitler in various attitudes of terror or despair, St. George vanquishing the Nazi dragon—all these and many others appear in lively colours on the fuselages of our aircraft. Often a station can produce an expert with the paint-brush—a signwriter in civil life, perhaps—and he will go to a good deal of trouble to meet the wishes of pilots who have a fancy for some particular emblem.

In the 1914-18 war the fashion among pilots was to paint part of their aircraft, usually the nose, some particularly vivid colour. The Germans went so far as to have the machines of whole squadrons painted one distinguishing colour. Considerations of camouflage preclude such dashing effects nowadays.

(Below) A pelican belonging to a fighter pilot of a Hurricane squadron in Cyprus finds an ME109 a tasty morsel.

LUNAR SPACE VESSEL

Possibilities of a Rocket Flight to the Moon : Release Velocity : The Fuel Question : Stability and Control : Landing Gear

By R. A. SMITH, Organising Sec., British Interplanetary Society

EVER since it was realised that the propulsive effect of a rocket is the result of the reaction upon it of the acceleration imparted to the emitted gases, it has been obvious that in this reaction lay the possibility of producing tractive effect independent of the surrounding medium.

Granted that the tractive effect is there, the next question to arise is whether it is of sufficient magnitude to make possible a flight to the moon and back.

Those who have considered such a flight think of it in the following terms:—

(1) Acceleration in the shortest possible time to "Release Velocity," with jets at full blast. This velocity having been attained, sufficient momentum would have been built up to carry the ship, at steadily decreasing velocity, to the lunar orbit. The force of gravitation acting on the ship would decelerate it, but its momentum would prevent its being brought to rest. "Release Velocity" may be defined as that velocity which a body will have attained at any point in a gravitational field as the result of having been permitted to fall freely under the influence of that field from infinity to that point, by this formula:

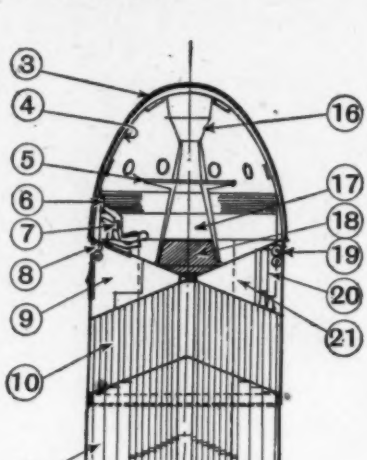
$$V = \text{Release Velocity} = \sqrt{2g\frac{r^2}{x}}$$

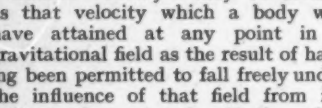
where g = gravitational acceleration at surface of body, whose radius is r, x being the distance from the centre of the body to the point at which it is desired to calculate "Release Velocity."

(2) Having reached the point at which the gravitational attraction of the Earth and Moon are balanced, the ship will begin to accelerate, increasing its speed until, at the appropriate moment, rockets are discharged towards the Moon, decelerating the ship to rest on the lunar surface.

(3) On return, the ship would be accelerated; by rocket discharge to lunar "Release Velocity," and then be permitted to coast under momentum.

(4) Re-passing balance point, the ship would accelerate in free fall towards the Earth, until, at the appropriate moment, rockets were again discharged, decelerating the ship to a velocity at which it would be safe to re-enter the Earth's atmosphere. From this point the ship would complete its descent by parachute, or other air-braking device.





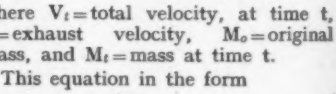


Fig. 1. Ship complete as at departure from earth's surface :—(1) Overhang of pressure cabin ; (2) Rocket tube (large size); (3) Outer shell (jettisoned after leaving atmosphere) ; (4) Inner shell of pressure cabin ; (5) Handrail and supports ; (6) Walkway ; (7) Firing control ; (8) Operator's couch ; (9) Airlock ; (10) Smaller tubes ; (11) Larger tubes (side view) ; (12) Cage ; (13) Thrust web ; (14) Radial observation port ; (15) Forward axial observation port ; (16) Instrument panel and parachute locker ; (17) Food and tool lockers ; (18) Firing current power pack ; (19) Torque jets ; (20) Axial liquid fuel control rockets ; (21) Space for air, water, and liquid fuel tanks ; (22) Cable duct.

It will be seen from the foregoing that the project consists of two periods of acceleration and two of deceleration, under power. The total effort will be the same as if these had been four successive periods of acceleration to a fictitious velocity, V_t, known as total Velocity.

Corrections would have to be applied to the value V_t, thus obtained, to allow for various factors, such as loss of time in attaining "Release Velocity," power reserve for approach and correction manœuvres, and allowance for atmospheric drag. Further corrections will be required to compensate for any change in weight, not directly connected with fuel consumption.

Exhaust Velocity

An equation can be derived, consistent with the conservation of energy and observed experimental results, as follows:—

$$V_t = -v \log_e \frac{M_o}{M_t}$$

where V_t = total velocity, at time t, v = exhaust velocity, M_o = original mass, and M_t = mass at time t.

This equation in the form

$$\frac{V_t}{\text{Log}_e \frac{M_o}{M_t}} = -v$$

relates exhaust velocity to payload ratio, which is the reason for the prominence given to exhaust velocities by "Astronautical" experimenters.

Directly it is announced that exhaust velocities of the order of 3.9 kms./sec. have been obtained in practical experiment (after correction to vacuum performance) it will be time to consider the details of a practical space-ship, providing the fuel is sufficiently compact.

Compactness is essential to reduce both container weight and the overall dimensions of the ship to reasonable figures.

The reason advanced by some experimenters for the use of liquid fuels is that by valving and throttling the

LUNAR SPACE VESSEL

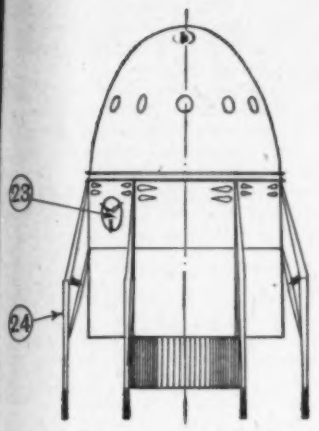


Fig. 2. Ship as on arrival at lunar surface. (23) Outer airlock manhole; (24) Retractable shock absorber legs.

mixtures it is possible to control their rate of combustion.

This is a perfectly valid argument, so far as it goes, and no doubt liquid fuels are very suitable for any purpose other than that of providing the main bulk of the fuel of a large-scale space-ship.

Liquid Fuels

Liquid fuels exist which could provide a high order of thermo-chemical energy, and there are few solid fuels, as yet developed, that can compare with them in this respect. The British Interplanetary Society, prior to the outbreak of war, were engaged in a very interesting line of research, and it is hoped that when it is found possible to resume, considerable improvement will be shown in the performance of solid fuels. If this proves to be the case, their greater density and inherent structural rigidity will make important foundation for their claim as the most suitable fuel for large-scale rockets.

The B.I.S. published a design for a space-ship using multi-tube solid fuel rocket-motors, arranged so that they could be electrically ignited in multiples to provide any desired thrust factor. The arrangement of these tubes, in honeycomb formation, is of such inherent rigidity that great structural economy may be achieved. An additional advantage claimed for this type of construction is that they may so be linked that when they cease thrust they automatically detach themselves and drop off, thus increasing efficiency by reducing deadweight at the earliest possible moment.

One-and-a-half Tons

A ship constructed on this principle, using a fuel producing 3.9 kms./sec. exhaust velocity, and with a return weight to the earth's atmosphere of 0.75 tons, would have an initial weight of 1,512 tons.

The weight would be disposed, as follows:—

	Tons.
Pressure cabin, crew, etc., parachute and harness..	0.75
Batteries, landing legs, food stores, tools, water, air	5.0
Outer shell	2.0
General structure, wiring..	80.0
Tubes, lagging, chokes, nozzles	275.0
Fuel	1,150.0
Total	1,512.75

There is far more to designing a space-ship than the finding of a sufficiently energetic fuel. It is possible for a fuel to be abundantly energetic, yet useless. It may be unstable, liable to detonation, or of too low density.

Apart from the question of suitable

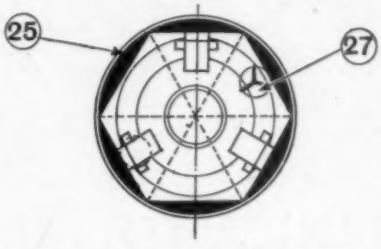


Fig. 3. (25) Rearward axial observation ports and (27) inner airlock manhole.

fuel, there are, as with the airplane, questions of stability and control. Many of the so-called "designs" for space-ships are equipped with an imposing array of wings and fins which could serve no possible purpose in the absence of an atmosphere.

In a rocket flight to the Moon 99.9 per cent. of the journey would be in airless space. Three minutes after taking off, the limits of the atmosphere would be passed at an acceleration of 2g. and a further period of 4½ minutes, at this rate of acceleration, would be required to obtain Release Velocity of 9.5 kms./sec. at 2,410 kms. Having attained this velocity, the rockets would cease firing, and the ship would "coast" under momentum, taking about 45 hours to reach the lunar orbit. Any attempt to direct the flight by fins, once free of atmosphere, would therefore be foredoomed to failure.

The B.I.S. Research Committee suggest the alternative of rotating the ship about its axis. It has been calculated that if the ship revolves once in three seconds, the gyro inertia would be such that if 10 per cent. of the tubes failed completely and if they were all placed in the most unfavourable position, as far from the centre of gravity as possible, the deflection would still be restrained within limits from which recovery could be made. Once rotation has been established, it will continue until some torque force is opposed to check it.

The moment of greatest directional instability is that immediately succeeding launching. A launching cradle has been devised, as an integral part of the scheme, which will enable the machine to accumulate sufficient rotary momentum before launching.

An additional advantage of axial rotation lies in the fact that the centrifugal force set up will simulate gravitation, which otherwise would appear to the crew to be lacking, directly the thrust impulse ceased. The apparent lack of any effective "gravitation" would cause nervous and digestive disorders, such as to produce acute nausea, rendering the crew powerless and probably senseless.

Gyro-precession

It is essential that it should be possible to stop or start rotation at will, as any attempt at change of direction would introduce gyro-precession which might become uncontrollable. Tangentially mounted opposed sets of manually controlled rockets are provided for this purpose. Six batteries of axially directed auxiliary rockets would provide adequate stability for approach manœuvres, and it is suggested that manually controlled liquid fuel rockets be used for this purpose. It is fortunate that the low gravitational potential of the Moon automatically implies a very slow rate of fall, thus mitigating, in part, the difficulties of the final approach.

Owing to the complete absence of eroding forces, the lunar surface will most probably consist of jagged splinters of rock intermingled with fissures to such an extent as to render a vertical approach the only possible

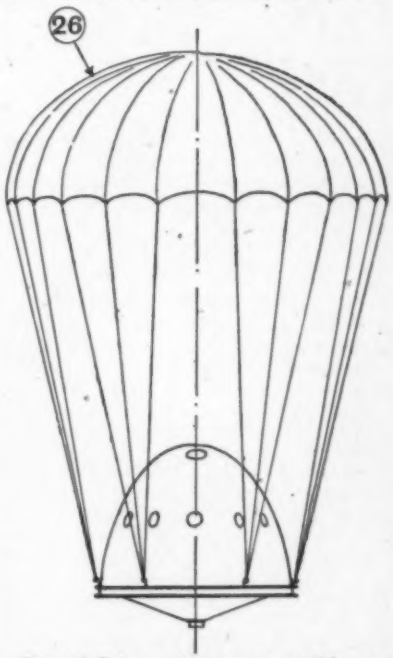


Fig. 4. Ship as at entry to earth's atmosphere on return flight. (26) Parachute.

LUNAR SPACE VESSEL

successful manœuvre. The B.I.S. design, therefore, provides six shock absorber, retractable landing legs for this purpose.

Exit to the lunar surface is provided through either of two airlocks situated at each side of the ship. Whilst on outside duty, the crew would be provided with pressure suits equipped with air regeneration, or reservoirs, and with means of controlling internal pressure and temperature.

Return Trip

Before departure for Earth, the crew would disconnect the under part of the vessel, so that it would become, in effect, a launching cradle, from which all that is required may be projected. Owing to the low "Release Velocity" of the Moon, no very great degree of directional accuracy is required, as the possible velocity error component will be small and easily corrected.

A further great saving in weight is effected in the B.I.S. design by the provision of an outer shell to the pressure cabin, which will withstand the pressures and temperatures generated in the latter moments of the passage through the atmosphere in the ascent. This enables the inner shell to be quite light, as it has only to contend with one atmosphere internal pressure. The outer shell is jettisoned directly the ascent thrust is completed. It is proposed to construct it of fused Alundum, suitably reinforced, and it is calculated that it will weigh two tons.

The presence of this outer shell will make it necessary to make the ascent without external observation. This is no great hardship as it would be wise to make any required adjustments of trajectory after the completion of the predetermined thrust period. It is assumed that ground observation would establish the components of the trajectory effected and would communicate the required corrections to the crew by Photo-telephone, as "wireless" radiation is not to be depended on beyond the "ionosphere."

Observation ports are provided in the B.I.S. design axially forwards, rearwards, and radially. A special optical system has been developed to provide an apparently stationary image of the field of view that would be revolving relative to the crew. This system, which is really a slow-motion stroboscope, has been demonstrated satisfactorily at South Kensington Museum.

Whether the intensity of cosmic radiation met with outside atmosphere is the final "no" to space-flight, experiment alone will tell.

Preliminary rocket flights up to and beyond the limits of the atmosphere are the only practical means of finding this out, and for that reason the attention of all "astronautical" experimenters must necessarily be focused upon the successful development of this prerequisite of space-conquest.

Its Object

The B.I.S. space-ship is not an attempt to put the cart before the horse. It is intended as a means of obtaining a bird's-eye view of the problem as a whole. Stringfellow, Maxim, Langley, to mention a few, did not wait for the barrel engine or the multi-row radial sleeve-valve air-cooled diesel—or four-stage variable-pitch contra-props!!! . . . they got on with the job.

I admit that I would not care to dive-bomb a flak-ship in a Stringfellow "Skinflint" . . . or, for that matter, I do not expect to have to fly the B.I.S. space-ship either.

DORNIER Do. 217E.

Familiar Appearance but Performance an Improvement on Earlier Types

THE external similarity of the Dornier 217E to the Do. 17Z and Do. 215 is misleading, since it is much superior in load-carrying capacity, range and all-round performance. Moreover, it can be readily adapted for operation as a dive-bomber. This particular machine is one of the E.1 series. It differs from the later E.2 model mainly in its lack of a gun-turret.

The primary duty of the Do. 217 series is bombing, dive-bombing up to a fairly steep angle being possible when a special diving brake is installed in the tail. It is also possible to use the aircraft for torpedo dropping, while its speed obviously suits it for strategical reconnaissance.

Differences in Detail

The Do. 217E resembles a scaled-up Do. 17Z or Do. 215, being a twin-engined, shoulder-wing monoplane with twin fins and rudders. The wing is thicker, and the fuselage, which is proportionately "fatter" than on the earlier Dorniers, extends behind the tailplane. The wing, like the fuselage, is made in three parts, two spars being used throughout.

Slotted ailerons are fitted and the flaps are of the split type; these are interesting in that they have a shaped nose cap. Each portion of the elevator has two tabs, one for balance and trimming and the other for automatic recovery from dives. An interesting aerodynamic feature is the incorporation of fixed slots in the leading-edges of the fins. These probably give improved rudder control when flying on one engine.

Probably the most notable feature of the aircraft is the power plant, which comprises two of the new B.M.W. 801 14-cylinder two-bank radials with fan cooling. Each of these engines is rated at 1,480 h.p. at 14,700ft. and 1,600 h.p. for take-off. The engines are enclosed in remarkably clean long-chord cowlings with frontal annular air inlets. Entry of air into the cowling is accelerated by a fan driven through gearing from the airscrew shaft. The oil cooler is installed under the leading-edge of the cowling and consists of finned segment-shaped tubes. A very elaborate internal system of ducts and baffles assists cylinder cooling. Each engine has two air intakes, both of which are entirely inside the cowling.

Another novel feature is the exhaust system. There is no collector ring, but instead there are six exhaust stubs on top, and four on each side of the engine cowling, projecting outwards over the nacelle. The four stubs on each side of the cowling discharge under the wing and the six on the top over the wing. Three-bladed wooden airscrews, utilising a hub of a new type, and having a pitch range of 86 degrees are fitted.

Bomb Loads

On the machine examined, four racks, each capable of carrying a 500-kg. bomb, were fitted in the bomb compartment, which is 20ft. long. Various combinations of bombs are possible when internal and external stowage is used. For example, it is thought that one or two bombs of 1,000 kg. could be carried inside the aircraft, while two 500-kg. bombs can be slung externally under the wings. Alternatively, at least one torpedo can be carried.

Armament and Armour

In the transparent nose, on the starboard side, is provision for a further gun of unknown calibre, and firing forward through the bottom of the cockpit is a fixed MG 151 of 15 mm. calibre. Mountings are provided for four lateral MG 15s (7.9 mm. calibre), but on the machine examined only the rear pair was installed.

There are three notable features in the armour-plate installation. Behind the pilot's seat is a screen of half-octagonal form, the thickness of the plate being 8 to 9 mm.; the dinghy recess in the top of the fuselage is armoured; a large piece of semicircular form is laid on the outside of the back of the fuselage immediately behind the cockpit.

There is another external section of armour-plate laid flat on the outside of the roof of the cockpit slightly to the rear of the pilot's head, and the bottom of the pilot's seat is protected. There is, however, no armour-plate for protection of the engines.

A picture of the Do. 217E is on page 131.

"G" MEN of the AIR

ON PILOTS FLATTENING OUT : AVOIDING THE PHYSIOLOGICAL ILL EFFECTS OF VIOLENT ACCELERATION

By F. C. SHEFFIELD

TACTICAL considerations in modern combat call for higher and still higher speeds from our military aircraft. Present-day machines can travel at more than 400 m.p.h. and dive at 500 m.p.h. or even, it is claimed, at 600 m.p.h. Through the ages the physical structure of man has been evolved to suit much lower speeds of locomotion. Mere velocity does not distress him, but violent acceleration and ultra-rapid change of the direction of motion can injure or even destroy him. Man cannot be redesigned—how can he be trained and adapted to meet these new demands? Can machines be developed in which the improved performance does not stress the pilot so drastically?

ON reflection it would appear somewhat strange that in the development of the art of flying man should have adopted a sitting posture. There would seem to be no natural precedent for this. Birds fly through the air with the longitudinal axis of the body lying in the direction of flight. Apart from a few freakish exceptions, fish progress in water in the same attitude. Man himself adopts that position when swimming. Presumably long familiarity with transport in carriages and more recent experience with motor vehicles led to the sitting position being adopted merely from custom and not for any reasoned consideration. Curiously enough, when Leonardo da Vinci, the fifteenth-century Florentine genius, studied the mechanics of bird flight and the possibility of human flight he logically assumed the prone position would be utilised. He made models to test his theories, and his sketches and notes on the subject are still in existence. At the beginning of this century, at the time when practical flight had just become possible, the Wright brothers in their earliest gliding experiments adopted the horizontal position.

In practice, of course, the sitting position has been entirely satisfactory for all normal purposes until recent times. With slow and medium-speed craft operating only with smoothly executed manœuvres there was no need to call for any change. With the advent of fighters and dive bombers capable of speeds between 400 and 500 miles per hour and rapid and complicated combined manœuvres the conditions have entirely changed, and the posture of the pilot has become a question of urgency. In actual fact, the performance of modern military machines has already outstripped the physiological capacity of the normal human structure.

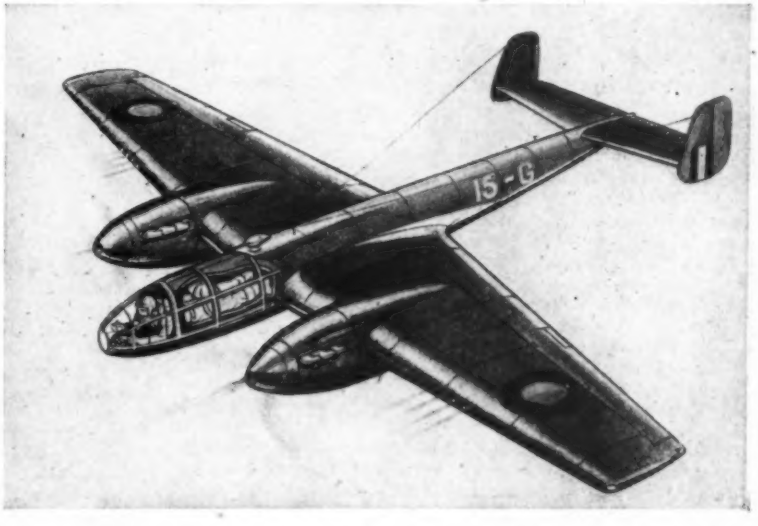
In its essentials the problem is an old one. Pilots in the High-speed Flight of Supermarine seaplanes competing in the Schneider Cup contests were prone to "blacking-out" when executing close turns. For these contests and certain aerobatics it was found advantageous to bind the legs and the stomach of the pilot in order to avoid discomfort and nausea.

The Effect of Acceleration

It should be noted that it is acceleration and not velocity that is liable to cause discomfort or injury to the pilot or crew of an aircraft. A normal man of sound constitution can easily stand an acceleration, in level flight, of 30 metres per second per second, and, providing this rate is maintained smoothly, he could, it is estimated, reach a velocity of 1,620 kilometres per hour (approximately 1,000 miles per hour) in 15 seconds without ill effects. It is particularly in executing close turns at high speed and pulling out of dives that the most violent accelerations are likely to occur. Apart from the physical condition of the pilot, there are three main factors which determine the effect of acceleration on the human body. These are (1) direction of acceleration, (2) magnitude of the acceleration, and (3) the period for which the acceleration is sustained. In the usual sitting position the centrifugal force acts in a direction from the head to the seat. The body presses tighter to the aircraft seat, the limbs feel heavier, the blood more weighty and heart action correspondingly more laboured. The heart is a pumping device and, similar to any mechanical pump, it is more difficult for it to raise blood to the head against the force set up by centrifugal action.

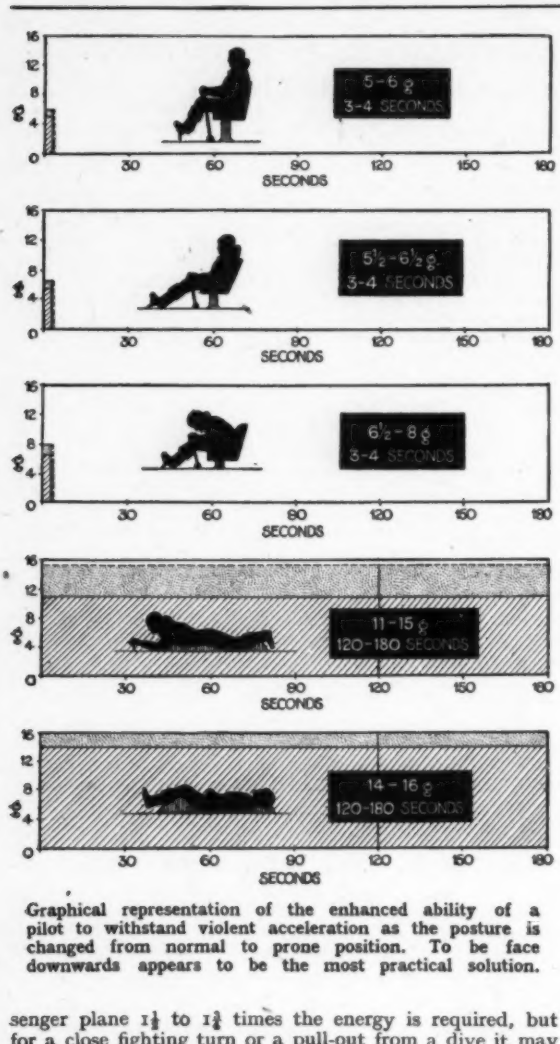
"Blacking-Out"

Minor effects of this character are commonly noted by fliers when spiralling for any considerable period. Varying in intensity, symptoms of faintness, dizziness, nausea or even vomiting may be experienced. "Blacking-out" is due to the same cause but of greater magnitude. The human vascular system is very elastic and when subjected to the pressures occasioned by rapid acceleration a large quantity of blood is stored in locally distended veins and arteries, and is thus temporarily withheld from circulation. As a result, a reduced quantity of oxygen is supplied to the brain and, as a first symptom, vision is affected and then a black-out occurs. If the excessive acceleration is continued, this is soon followed by a complete loss of consciousness. When the acceleration ceases vision rapidly recovers, but if loss of consciousness has occurred it will persist for several seconds. A simple indication may be given of the work which the heart is called upon to perform in various manœuvres. Compared with that needed under normal conditions, at a wide turn in a pas-



An imaginative impression of a fighter-dive bomber with the pilot in the prone position. Controls will be on a miniature scale and necessarily servo-assisted, either hydraulically or electrically. Lying on an armour plate platform the pilot is enshrouded with an arched casing of armour plate which can slide to the rear to facilitate entry.

"G" MEN OF THE AIR



Graphical representation of the enhanced ability of a pilot to withstand violent acceleration as the posture is changed from normal to prone position. To be face downwards appears to be the most practical solution.

senger plane 1½ to 1¾ times the energy is required, but for a close fighting turn or a pull-out from a dive it may be as much as eight times.

What the Average Man Can Withstand

Tests have shown that a normal healthy individual occupying the usual sitting position in an aircraft can be subjected to an acceleration of 5 to 6 *g* for a period of 3 to 4 seconds without ill effects.* Translated into practical operation this would mean that at a speed of 370 miles an hour the radius of a turn should not be less than about 550 yards. Obviously such a limitation is not admissible for modern fighters and dive-bombers.

If our vascular system consisted of rigid tubes, such a distention as mentioned earlier could not occur, and circulation would not be materially affected. This fact, however, must not lead to the conclusion that prosperous old City gentlemen who suffer from hardening of the arteries would make ideal fighter pilots. Whilst they may be constitutionally sound, they do not necessarily possess sound constitutions.

In theory it should be possible to minimise the effect of acceleration by supporting the body in a dense fluid sealed in a rigid tank. This idea would not seem capable of practical realisation. A step in this direction, however, is indicated by a recent U.S. patent for a double-walled flying suit that can be filled with air or liquid under pressure to furnish an evenly distributed support for the wearer's body. It could, of course, be suitably equipped with a hood and serve also as a pressure suit for high altitude.

The normal individual can withstand a further 0.5 to 1 *g* for the same period if the legs and stomach are bandaged. Further improvement is obtained if a substantial meal is taken some little time before experiencing the acceleration. This arises from the fact that digestion automatically induces an accumulation of blood in the intestinal region, and thus avoids any large-scale displacements of the blood stream under the effects of acceleration. The inhaling of a CO_2/O_2 mixture is also of assistance, as it facilitates the circulation of blood in the brain.

Advantageous Postures

By lowering the seat, raising the legs, bending the body forward to a crouched position, and making use of all the minor aids mentioned earlier, it is possible for the pilot to withstand acceleration of the order of 7 to 8 *g*. for a period of 3 to 4 seconds. To achieve any marked improvement, however, it is necessary for the pilot to lie in a prone position. In this way centrifugal force at the turn or pull-out is exerted approximately at right angles to the line of the main blood vessels instead of being substantially parallel, as is the case when the pilot is sitting normally. Relative to the direction of this force, the height of the head above the heart is reduced, the displacement of blood is less sudden, and the ill effects much less marked. Laboratory researches, confirmed by practical experience, show that it is possible for accelerations of 11 to 15 *g*. to be withstood for 2 to 3 minutes with the pilot lying face downwards. A slight improvement to the extent of 1 *g*. for the same period is possible if the pilot reclines on his back. Under carefully controlled conditions it is possible for these periods to be somewhat extended.

Although to lie on the back is advantageous as regards acceleration, it is not so conducive to good breathing. In this respect it was found preferable to lie face downwards with the chest supported on the parachute pack. It is presumed that the action of the diaphragm is better in this position. Thus, to lie face downwards in a recumbent position would appear to offer the best compromise solution for acceleration, breathing, and also for facility of vision. Experiment showed that neither back nor face prone position was more tiring to the pilot than the sitting posture.

Specialised Training

By specially designed courses of physical training and regular practice, much can be done to accustom the heart and the vascular system to accelerations which would normally cause distress or even hæmorrhage. In Russia special sequences of exercises have been developed and special training equipment produced for this purpose. One device known as the "Triplex Trainer" consists of three rings revolving one within the other in different planes. The pupil rotates the inner ring by continually changing his centre of mass. Meanwhile the medial and outer rings are set in motion, and thus the pupil is subjected to most complicated conditions of acceleration.

So far this survey of the problem has resolved itself into an examination of the limitations which the human structure imposes upon the performance of aircraft. No useful purpose is served by producing high performance machines with large load factors if the crews are physically incapable of withstanding the effects of such a performance. There is, however, a diametrically opposed viewpoint to be considered. German researches and experiments are claimed to show that the human body can stand very high accelerations if the period of application is strictly limited to less than one second. As high as 26 *g*. is feasible if maintained for no longer than one-fifth of a second. No present-day machine could be pulled out of a dive in so short a time, and there is reason to

* A freely falling body has a constant acceleration, termed "gravity acceleration" and usually indicated by "*g*." Its value is subject to slight variation in accordance with latitude and height above sea-level. Unless specifically corrected for these factors, the value of "*g*" is that for London—32.2ft./sec.² or 32.2 feet per second per second.

"G" MEN OF THE AIR

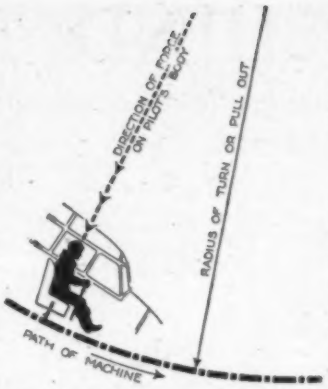
doubt if a practical machine with a useful performance could be stressed for such drastic handling.

Practical Experiments

German, Russian, American and British designers are known to be investigating the problem. Germany has disclosed her experiments in some detail, but the other countries have been more discreet. Thus, particulars have been given of an experimental twin-engined Heinkel fighter credited with a maximum level flight speed of 430 m.p.h. This was arranged for a crew of two to lie prone in the wings. Gliders have also been utilised for experiments in Germany, and the performance was found to be considerably improved owing mainly to reductions of frontal area and the total skin frictional area of the fuselage. It may be noted that a cabin cross-sectional area of about 16 sq. ft. is required for a sitting posture, whilst only about 4 sq. ft. is essential for a prone position.

Suggestions have been advanced for mechanically operated adjustable seating arrangements which would make possible a change from a sitting to a recumbent position. These, however, would not appear to be of a practical character on the score of weight, cost, complication and the difficulty of providing a control system which could be operated with equal facility from either position. In any case, the advantage of reduced cross-sectional area of the fuselage would be lost.

It would be possible to fairly effectively protect a prone pilot with armour by housing him in a cylinder or mounting him on a dished platform provided with a sliding arched enclosure. In the nose of the fuselage would be a bullet-proof sighting panel of optically worked laminated glass. For baling out in emergency it would be possible to provide the cylinder or platform with a quick-releasing jettison gear by means of which the pilot could be dropped clear of the machine.



This diagrammatic sketch indicates how centrifugal force exerted on the body of a pilot in the normal sitting position tends to drain the blood from the head and concentrate it below the heart.

The scheme is full of possibilities and, if present-day speeds are to be increased, some move in this direction would seem inevitable. The importance of dive-bombing tactics has been exhaustively demonstrated in recent campaigns. Any design modification that can offer reasonable prospects of greater manœuvrability, increased diving speed, lower and quicker pull-out, and consequently more accurate delivery of a bomb, must receive serious and immediate attention.

[For certain of the facts quoted, acknowledgment must be made of material collected and translated by the Directorates of Scientific and Technical Development, Ministry of Aircraft Production.]

BOULTON PAUL DEFIANT (Cont. from p. 134)

carriage goes home to its retracted position, by a hydraulic jack, the control valve for which is operated by the undercarriage on reaching its fully retracted position.

Undercarriage retraction is fully effected by an hydraulic jack, whose ram is attached to one angle of a triangular lever, which lever is pivoted at a second angle to the upper part of the "break-back" strut and whose third angle is linked to the lower upper part of that strut.

The upper fairing of the fuselage surmounting the flat decking of the fuselage frame proper is, in the main, a light spruce and three-ply structure. The frame of the pilot's windscreen is the main exception, being a light alloy casting. This fairing is in two main portions, corresponding to the two sections of the fuselage.

The front section of this fairing carries on the cross-section of the pilot's windscreen right back to the gun turret cupola, but the portion of this windscreen "tail-piece" comprises a section which can collapse downwards to permit of the passage past it of the guns in the turret.

The rear upper fairing tapers away from a section similar to that of the front fairing just aft the turret to a slightly domed section at the tailplane. The central portion of this fairing, which is just aft of the turret, corresponds in section to the windscreen, is hinged on a transverse axis some half-way back along the rear fuselage and, like the corresponding part of the fairing ahead of the turret, may be collapsed to permit of the turret guns passing by.

The two hinged portions of these fairings in their raised position extend up to near the top of the turret cupola, and serve very effectively to fair the turret, and do in fact very greatly reduce its resistance.

These two collapsible fairings are operated by pneumatic jacks, the control valves for which are operated automatically by cams on the turret in such a manner that the fairings collapse only when it is necessary to allow the guns to be traversed past them.

The Boulton Paul turret—which is a removable, self-contained unit—mounts four 0.303in. belt-fed guns. This unit has proved itself to be a very effective and accurate lethal weapon, and is found to be very economical in its demand for operating power. This latter point is due mainly to the high overall efficiency of the hydraulic variable-gear system incorporated in the control layout.

It should here be made clear that the whole of the hydraulic system for turret operation is part of the turret unit, and has no connection with any hydraulic system outside of the turret.

The Defiant power plant consists of a glycol-cooled Merlin III engine rated at 1,030 b.h.p. at 3,000 r.p.m. at 16,500ft., driving a De Havilland constant-speed three-bladed airscrew of 11ft. 6in. diameter through a reduction gear of 0.477 ratio.

Fuel is supplied to the engine from two fuel tanks—carried in the outboard extremities of the centre section of the wings—by an engine-driven fuel pump. Normally the two tanks are coupled to the pump, but a three-way cock permits of either tank being isolated.

Good Forward View

The pilot's seat in the Defiant is, relatively to that of the majority of modern single-engine fighters, unusually far forward relative to the wings, and consequently the view for landing and take-off is better than in the majority of machines of generally similar layout.

The seat is adjustable for height; and the control column is arranged to move with the seat, so that raising and lowering the seat leaves the relative position of pilot to stick unaltered. This is achieved by pivoting the control column in a ball joint supported from the seat frame.

The fairing which joins up to the pilot's windscreen, comprising both the roof panel and the side panels, is carried out on a fore-and-aft track, and may be slid bodily back over the fixed upper deck fairing and the forward collapsible fairing for the turret, so that the cockpit may be completely opened for exit and entry, and may be part opened in flight, to give a view upwards and on each side of the windscreen unobstructed by glazed panels.

BEHIND THE LINES

Service and Industrial News from the Inside of Axis and Enemy-occupied Countries

Oberammergau Passion Plays

CHIEF actors in these festival plays have been drafted into the *Luftwaffe*, and are now serving as observers on Bavarian mountain peaks on the look-out for R.A.F. raiders.

A Quisling Firm

TO make sure of a better exploitation of Norway's bauxite resources, a new German-controlled Norwegian firm has been established: the "Nordag," registered in Oslo with a capital of 70 million Kr., is to produce light metals for the German industry.

New "Met" Balloons

RUBBER registering or sounding balloons for the *Luftwaffe* Meteorological service are being replaced by a new type made from transparent foils. Caprophan, the material used, is only 0.0065 mm. thick. The transparent foils are black and dull and heated by sunray absorption. It is claimed that the material does not deteriorate under the influence of ultra-violet rays, rain or cold. The balloon is protected by a fine net. At a volume of 953.49 cu. ft. an altitude of 24 miles is said to have been reached.

The Fun of the Fair

A STATE sub-contractors' exchange has been opened in Berlin to supervise regional centres at Hamburg, Nuremburg, Munich, Stuttgart, Vienna, Prague, The Hague, and others in the Ruhr.

These regional exchanges are organised on lines of permanent industrial "fairs" where sub-contractors meet the principal manufacturers and have the opportunity of exchanging views and making arrangements for production. The new centre in Berlin is to co-ordinate further the activities of the regional exchanges and to give opportunity of contact between such industrial firms as may be scattered all over Germany.

Aircraft Production in Poland

PRODUCTION is reported to have started in the new "Aircraft works Gotenhafen" at Gdynia, the beautiful and modern port of Poland on the Baltic Sea. Gotenhafen is the Nazified version of the ancient Polish name of Gdynia.

Italian Dispersal

THE difficulties of coal supply are acutely felt by various Italian industries. This problem seems to occupy much time of the deliberations of the Italian Senate. Failing to produce other remedies, the Senate Committee for Public Works passed a Bill providing for the dispersal of Italian industrial plant to such regions where industrial power is provided by hydro-electric sources. It is possible that another motive for this dispersal is a better protection against R.A.F. bombs which made a deep impression in Italy.

Acantholyda Erythrocephala v. Goering

THIS insect seems to trouble the Nazis so much that the Reichsmarshal, who is also in charge of the forests, has ordered special squadrons of the *Luftwaffe* to fumigate affected forests. The annual damage caused to German forestry by this insect amounts to about £200,000.

Old Junkers specially adapted for insecticide spraying are used on the job, and crews provided with special protective clothing. For pilots returning from the Russian front, this kind of insect fighting is a welcome method for reconditioning and flying fitness.

Luftwaffe Cadets

A SPECIAL section for the training of future professional officers of the *Luftwaffe* has been opened at the Institute for National Political Education at Potsdam. Besides the usual school subjects, pupils receive instruction in aeronautics, navigation, photography, meteorology and mechanics. Most important subject is gliding, terminating in a glider pilot licence. Some graduates of this course are already serving with the *Luftwaffe* as second lieutenants.

To Accelerate Training

ITALY is suffering from an acute shortage of aircraft engineers and other aeronautical specialists. To counteract this situation, contributions up to one million lire have been granted to the Aircraft Engineering Section of the Rome University and the Turin Institute of Technology for aeronautical training. These two institutions have already made available 77 scholarships of 10,000 lire each. Competition for the scholarships is open only to graduates of technical colleges who have received their diplomas between 1935 and 1940. Further sums have been earmarked to provide the necessary laboratories and aeronautical courses in Naples, Milan and other centres.

"One must look beyond the clouds for the sun," says this notice on an enemy airfield in Russia. But even such hopes are reduced. Airfields covered with thick snow are flooded when the weather improves. Each morning the first task of the crews is to scrape off the ice and snow from the fuselage and airscrews.

HERE AND THERE

To Help Pilots' Fund

ORGANISERS of the R.A.F. Pilots' and Crews' Fund have hit on a good idea for raising money for this fund for "The Few."

Copies of *Together We Fly*, by S.M-M., autographed by some of the characters in the book, are being auctioned by members of the Auctioneers and Estate Agents' Institute.

Among the characters whose exploits are recorded are Wing Commander Bader, double D.S.O., D.F.C., Sergeant Hannah, first Scots R.A.F. V.C. of this war, Group Captain Staton, another "double-double" — D.S.O., D.F.C. — and others whose names are less well known.

The idea originated at Bristol, where the first copy was sold for £20 by Mr. J. F. Linney, President of the Institute.

Far-flung Forced-landing

THIS story about the training days of a Scottish pilot now in a Coastal Command Squadron is told by his colleagues.

He had taken up an Anson, solo, and, after several hours, his C.O. received a telephone call. It was the Scotsman, reporting regretfully that he had had to make a forced landing.

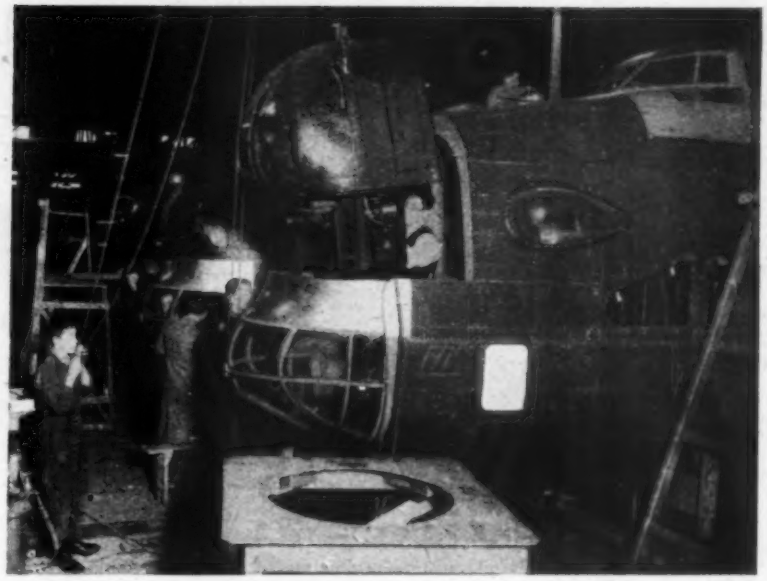
"Are you all right?" enquired the C.O. The answer was reassuring.

"I suppose you've put an armed guard on the aircraft?" asked the C.O.

"Weel, sir, no' exactly, sir," replied the Scot.

"But man, you know that a guard must always be put on a forced-landed aircraft—go and do it right away!"

"Weel, sir," replied the Scot hesitatingly, "it's a wee bit deeficult. Ye see—*the aircraft's in four different fields!*"



NOSE PROTECTION: Hoisting a two-gun power-operated turret into the fuselage of a Handley Page Halifax.

X-ray Analysis in Industry

THE Institute of Physics is arranging a conference on "X-ray Analysis in Industry" to be held in Cambridge on April 10th and 11th. The purpose of the conference is to promote the interchange of knowledge and experience between those employing X-ray Analysis (diffraction methods) in their work in different fields and to arrange for further collaboration between physicists, engineers, chemists and others towards the solution of problems by its methods.

During the conference the President, Professor Sir Lawrence Bragg, will lecture on "The History and Development of X-ray Analysis." Further particulars can be obtained from the Secretary of the Institute of Physics, Temporary Address: at The University, Reading, Berks, to whom application for accommodation in Cambridge should be made before February 14th.

HORSE BOX: Crating a North American Mustang for delivery by ship to England. To withstand the damp salt atmosphere and the many jars on the long journey the utmost care is taken in packing. The fuselage is entirely wrapped in waterproof paper.

Aircraft Workers Help Sailors

THE Merchant Navy Comforts Service, 62, Heath Street, London, N.W.3, has received a series of generous donations from the Employees' Charity Fund of Phillips and Powis Aircraft, Ltd., Reading. Gifts during January have amounted to £25 1s. 9d.

Lord Leathers, Minister of War Transport, is opening at the Baltic Exchange, E.C.3, on February 23, a fortnight's exhibition of the work of the Merchant Navy Comforts Service, the Sea War Libraries, and the Ship Adoption Society.

Technical Scholarships

SCHOLARSHIPS are offered at Northampton Polytechnic, St. John Street, London, E.C.1, a junior technical school for instrument making and horology, to which pupils are admitted at 13 to 14½ years of age, conditional upon passing an entrance examination to be held on Monday, March 23rd.

Two of these scholarships, tenable for the duration of the three years' course, are provided by the Worshipful Company of Clockmakers, and are worth £40 per annum. These are open to all pupils eligible for admission to the school.

There is also an L.C.C. Junior Technical Exhibition, open to pupils normally resident in the L.C.C. area (apart from evacuation), which also provides free tuition for the complete course, plus a small maintenance allowance dependent upon the financial position of the parent. Candidates for this exhibition must be between 13 and 14 years of age on April 1st, 1942, but no separate application is required.

All three awards are made on the results of the entrance examination.

As a war measure, the school has been evacuated to Fishpool Street, St. Albans.

THE JUNKERS JU 88 A-6

Performance Trials With and Without External Bombs : 33 m.p.h. Lost at 16,000ft. : Gross Weight Not the Same in all Tests

FOLLOWING upon the publication in our issue of last week of the article on the latest Messerschmitt, the Me 109F, we are able to present to our readers the results of performance trials which have been carried out in this country with the latest Junkers Ju 88, the A-6. We are indebted to the Minister of Aircraft Production, Lt. Col. J. T. C. Moore-Brabazon, for placing at our disposal the material upon which the following article is based.

The original Ju 88 will be familiar to readers of *Flight* from the illustrated descriptions which appeared in our issues of October 3rd, 1940, and December 5th, 1940; but in order to assist in appraising the results of the performance trials it may be helpful if a brief reference is made to the original Ju 88, and to the essential differences between it and the newer version with which the performance trials were made.

The Ju 88 is a low-wing, twin-engined monoplane of all-metal construction. The liquid-cooled, in-line Jumo 211 engines are enclosed in cylindrical cowlings which also carry the coolant and oil radiators and the air intakes. Cooling is controlled by gills of the type used on radial engines. The gills may be set in six positions, and are operated electrically; the gills on the port and starboard engines can be operated independently.

The engines are fitted with two-speed superchargers. By setting the gear control lever to the "Automatic" position, the gear is automatically changed at about 8,500ft. by means of an altitude capsule. The three-bladed airscrews are of the V.D.M. variable-pitch type, the pitch being changed by means of an electric motor under the pilot's control.

The undercarriage legs and wheels retract backwards into the engine nacelles, and are completely enclosed when retracted.

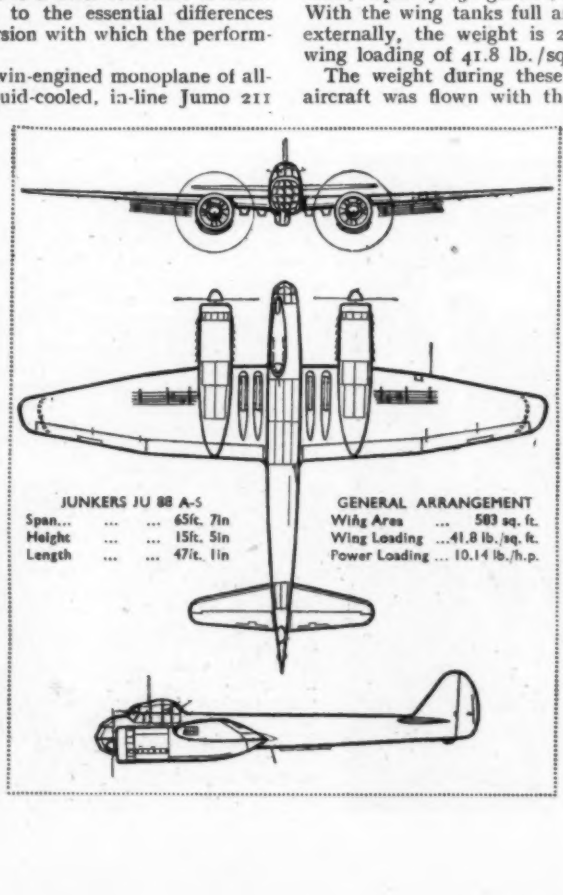
Provision for a lower rear gunner is made by means of a gondola under the starboard side of the cockpit.

The aircraft can be used as a dive-bomber, being fitted with dive brakes just outboard of the nacelles. When retracted, these do not recess into the wing, but on the Ju 88 tested are of slightly cleaner design than those on early Ju 88s.

The four external bomb racks fitted to the wing between the nacelles and the fuselage are well faired.

The standard petrol capacity is 638 gallons; there are four wing tanks, each of 92 gallons capacity, and a fuselage tank capacity of 270 gallons. Occasionally a jettisonable tank, capacity 150 gallons, is carried in the aft bomb bay. With the wing tanks full and four 250 kg. bombs carried externally, the weight is 24,350 lb., corresponding to a wing loading of 41.8 lb./sq. ft.

The weight during these tests was kept low, and the aircraft was flown with the fuselage tank empty. The maximum overload weight of the aircraft is about 28,500 lb.; at this weight some form of assistance is used for take-off (flywheel winch or rockets).


JUNKERS JU 88 A-5
Span... ... ... 65ft. 7in
Height 15ft. 5in
Length 47ft. 1in
GENERAL ARRANGEMENT
Wing Area ... 583 sq. ft.
Wing Loading ...41.8 lb./sq. ft.
Power Loading ... 10.14 lb./h.p.

Main differences between the original Ju 88 A-1 and the 88 A-6 are an increase in wing span, and consequently wing area; metal-covered ailerons of slightly larger span, provision for attachment of balloon cable fender, fitting of a new type of dive-bomb sight; and installation of new radio equipment.

The wing span of the Ju 88 A-6 has been increased by extending the leading and trailing edges, so that the rounded wing tip is of narrower chord than was the original. The span has been increased by about 6ft., from 59.8ft. to 65.6ft., which has increased the wing area to 583 sq. ft.

Protection against ice formation is in the form of hot-air pipes in the leading edge of the main planes.

(The leading edge of the tailplane has a full-span pulsating rubber overshoe type of de-icer.) One of the hot-air pipes in the cabin has been extended to form a demisting spray for the pilot's windscreen.

Attachment points for the balloon cable fender are provided on the wings and on the nose of the fuselage. Those on the wings are farther outboard than the corresponding points on the Heinkel He 111. On the fuselage there are four attachment points on the front fuselage ring, presumably to take the four legs of a pyramid projecting forward from the nose.

New Bomb Installation

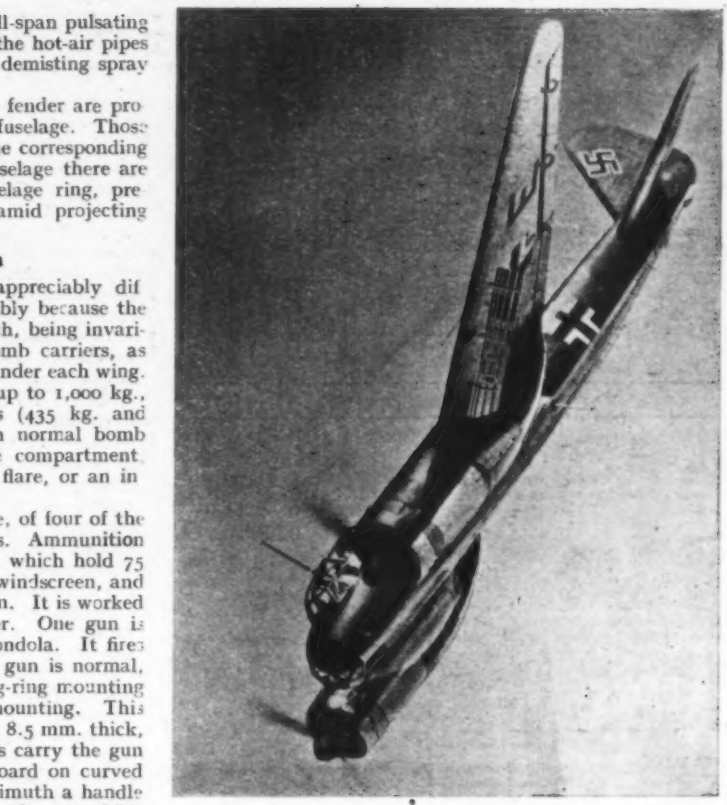
The bomb-release gear installation is appreciably different from that of the earlier type, probably because the forward bomb bay is no longer used as such, being invariably occupied by a fuel tank. Two bomb carriers, as normally fitted to the Ju 88, are provided under each wing. This type of carrier is suitable for bombs up to 1,000 kg., for large containers of incendiary bombs (435 kg. and 900 kg.), or for extra petrol tanks. Ten normal bomb carriers are fitted in the middle fuselage compartment, each capable of taking a 50 kg. bomb, a flare, or an incendiary bomb container.

Armament consists, as in the earlier type, of four of the usual M.G.15 type, 7.92 mm. machine guns. Ammunition is contained in 29 of the usual magazines, which hold 75 rounds each. One gun is mounted in the windscreen, and can be used either as a free or as a fixed gun. It is worked either by the pilot or by the bomb aimer. One gun is mounted in the rear end of the bottom gondola. It fires aft and downwards. The position of this gun is normal, but the mounting is new. The usual swing-ring mounting is replaced by a well-armoured sliding mounting. This consists of two curved armour-plate shields, 8.5 mm. thick, one on each side of the gun. These shields carry the gun and are arranged to slide to port or starboard on curved rails. To move the guns and shields in azimuth a handle is provided, fitted with a spring-actuated plunger which must be pressed down to unlock the mounting and held down during the movement of the gun and shields. Secondary movement of the gun in azimuth and in elevation during firing is catered for by the standard type of attachment of the guns to the shields. The floor of the mounting is of 7 mm. thick armour plate. The side walls are Perspex type panels. The field of view from the mid-under position is very poor, due to the armament shields. Moreover, the mounting requires considerable physical effort to manœuvre it.

Two guns are mounted in the mid-upper position in swing-ring mountings. The swing rings are located in the rear of the cockpit cover, project approximately 3in., and face slightly to the sides. The glass vision panel within the rings is modified into a kidney shape, occupying practically the whole of the ring except the part in which the gun is actually mounted. Visibility through the panel is poor.

Armour Protection

Armour-plate protection is afforded, in addition to that mentioned above, by a back plate, side pieces, head protection, and slats under the seat, for the pilot. The wireless operator is protected by 7 mm. armour plate between the swing rings and by 5 mm. plate surrounding them. A folding flap of armour plate protects the gunner's chest, and is hinged to give access to the wireless panel (8.5 mm. and 4 mm.). Protection from below is provided by 4 mm. plate under the seat.

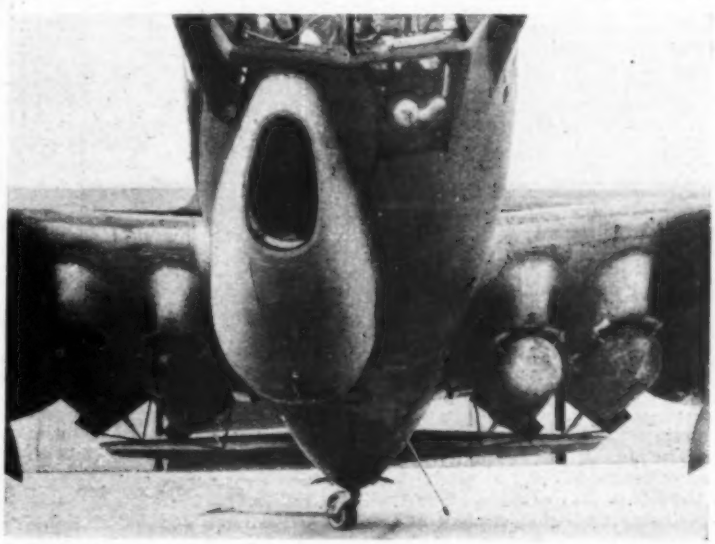


In the diving attitude, with air brakes down, the Ju 88 reaches a speed of some 340 m.p.h. It is used for "precision" as well as dive bombing. In the A.6 the brakes, when folded, lie more nearly flat against the surface than in the earlier model.

The mid-gunner is protected by strips 4 mm. thick fitted along the floor of the gondola under the fuselage.

A dive-bomb sight, type B.Z.A.1 (also known as the I.V.R.1 and I.K.R.1), is fitted. The actual sight is mounted from the roof of the pilot's cockpit. When not in use it is stowed in the top left-hand corner so as not to interfere with the field of view. The computer is mounted in the rear fuselage compartment.

Performance tests have been done on the Ju 88 Type



A close-up view of the front of the Ju 88 showing the four 250-kg. bombs carried on external streamline racks. The blister houses a gun position firing aft.

THE JUNKERS JU 88 A-6

A-6 (2 Jumo 211G engines). The salient results emerging from these tests are given in the accompanying tables:—

FULL THROTTLE LEVEL SPEEDS (Engine r.p.m. 2,400); Engine Cowling Gills closed

Loading Condition						
External Bomb Racks	Four 250 kg. Bombs (external)	Petrol	Weight lb.	Height ft.	Speeds T.A.S. m.p.h.	Supercharger gear
Off	Off	Inner wing tanks half full ...	19,870	16,000	281	High
On	Off	Wing tanks full...	22,200	16,000	276	High
On	On	Wing tanks full	24,350	16,000	248	High
Off	Off	Inner wing tanks half full ...	19,870	5,000	261	Low

CLIMBS

Loading Condition								
External bomb racks	Four 250 kg. bombs (external)	Petrol	Weight lb.	Height ft.	Flying speed T.A.S. m.p.h.	Rate of climb ft./min.	Service ceiling (100 ft./min.) ft.	Engines
Off	Off	Wing tanks full.	21,800	6,000	130	1,370	—	"Combat" 1.15 Ata, 2,300 r.p.m.
On	Off	Wing tanks full.	22,200	16,000	130	1,100	26,000	Full throttle 2,300 r.p.m.
On	Off	Wing tanks full.	22,200	16,000	130	1,190*	26,700*	Full throttle 2,400 r.p.m.
On	On	Wing tanks full.	24,350	16,000	140	700*	21,000*	Full throttle 2,400 r.p.m.

* Estimated values.

TAKE-OFF DISTANCE (mean of two take-off runs), Corrected to Zero Wind and Standard Atmospheric Conditions.

Loading	Distance start to take-off (Mean) Yards	Distance start to 50ft. (Mean), Yards
Four 250 kg. bombs carried externally. Wing tanks full. Weight 24,350 lb. ...	690	1,028

The programme of tests covered the following points:—

(1) Determination of the position error curve.
(2) Measurement of full-throttle level speeds (*a*) with the external bomb racks off; (*b*) with the external bomb racks on but with no bombs; (*c*) with four 250 kg. bombs carried externally. Speed measurements were also made at the "combat" rating (boost pressure 1.15 ata, 2,300 engine r.p.m., rich mixture).
(3) Partial climbs at 6,000ft. at "combat" rating with the external bomb racks off (superchargers in low gear).
(4) Determination of the ceiling by a climb from 16,000ft. at full throttle and 2,300 engine r.p.m. (superchargers in high gear).
(5) Measurement of take-off run with the external bombs carried and the wing petrol tanks full.

Nursing the Engines

In order to conserve the engines, full throttle (1.35 ata boost pressure, 2,400 engine r.p.m., rich mixture) was used as little as possible. Full-throttle running is only allowed for three minutes, and, when the cowling gills are closed, invariably results in overheating of the engines. Again, to avoid overheating, above the full-throttle height with the superchargers in high gear, full throttle and 2,300 engine r.p.m. (not 2,400 r.p.m.) were used. Except for a few points, the measurements at low heights were made at the "combat" rating (1.15 ata boost pressure, 2,300 engine r.p.m., rich mixture). The cruising conditions are 1.10 ata boost pressure, and 2,100 engine r.p.m., weak mixture.

The aircraft was timed at various speeds over a 7½ miles speed course in order to establish the position error curve. The points are plotted in Fig. 1A. These indicate that the position error is independent of speed over the range 160 m.p.h. to 220 m.p.h. I.A.S., the mean value being −¾ m.p.h.

The electrically heated pitot static head extends forward from the leading edge of the port wing. The distance of the head from the leading edge is 4.22ft.; the local wing chord is 8.9ft., and the local wing thickness about 12 per cent.

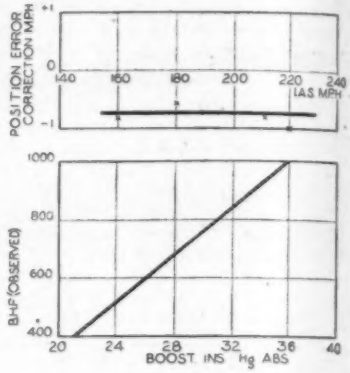


Fig. 1A (top): Position error correction curve. Fig. 1B (bottom): Variation of B.H.P. with boost pressure at constant speed of 2,300 r.p.m. from + 3 lb. per sq. in. boost, ground level intake, for Jumo 211 D engines. Fuel, 92 octane, supercharger in low gear. The curve can be applied to Jumo 211 E engines.

The full-throttle level speeds obtained under various conditions are shown plotted against height in Fig. 2A. The corresponding boost pressures are given in Fig. 3A. The engine cowling gills were in the closed position throughout.

Speeds were corrected on the density basis above the supercharged height and on the pressure basis below the supercharged height. Boost was corrected on the half-and-half basis above the supercharged height and on a pressure basis below these heights.

The full-throttle height with the superchargers in high gear is 16,000ft.; the estimated full-throttle height with the superchargers in low gear is 7,500ft.

With the external bomb racks off and the inner wing tanks half full (total weight, 19,870 lb.), the full-throttle maximum level speed is 281 m.p.h. T.A.S. at 16,000ft. with the superchargers in high gear, 2,400 engine r.p.m.,

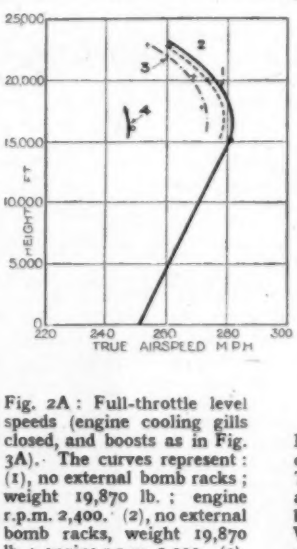


Fig. 2A: Full-throttle level speeds (engine cooling gills closed, and boosts as in Fig. 3A). The curves represent: (1), no external bomb racks; weight 19,870 lb.; engine r.p.m. 2,400. (2), no external bomb racks, weight 19,870 lb.; engine r.p.m. 2,300. (3), external racks, no bombs; weight 22,200 lb.; engine r.p.m. 2,300. (4), external bombs; weight 24,350 lb.; engine r.p.m. 2,400.

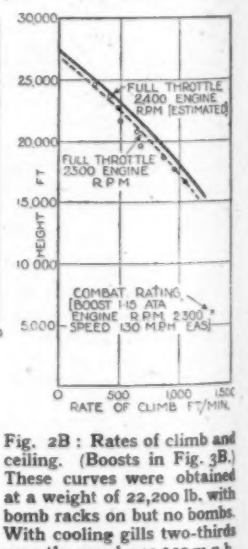


Fig. 2B: Rates of climb and ceiling. (Boosts in Fig. 3B.) These curves were obtained at a weight of 22,200 lb. with bomb racks on but no bombs. With cooling gills two-thirds open the speed was 130 m.p.h. at 16,000 and 18,000ft. and 125 m.p.h. at 20,000 and 22,000ft. With cooling gills one-third open the speed was 120 m.p.h. at 24,000ft.

THE JUNKERS JU 88 A-6

and rich mixture. This speed is maintained up to about 17,500ft.

At 5,000ft. with the superchargers in low gear the full-throttle level speed under the same condition is 261 m.p.h.

Comparative speeds with the external bomb racks and bombs fitted were only obtained above the full-throttle height with the superchargers in high gear.

Fitting the external bomb racks (no bombs) and increasing the weight to 22,200 lb. by filling all the wing tanks decreases the full-throttle level speed by 5 m.p.h., giving a maximum level speed at 16,000ft. of 276 m.p.h. T.A.S.

With four German 250 kg. bombs carried externally and the wing tanks full, the weight was increased to 24,350 lb. In this condition the maximum level speed at full throttle at 16,000ft. is decreased a further 28 m.p.h. to 248 m.p.h.

A number of level-speed measurements were made at the "combat" rating (1.15 ata boost pressure, 2,300 r.p.m.). Rich mixture is again used at this rating. The results are given in Fig. 5A.

SUPERCHARGERS IN HIGH GEAR
FULL THROTTLE 2300 ENGINE RPM
FULL THROTTLE 2400 ENGINE RPM
ESTIMATED FULL THROTTLE 2400 RPM SUPERCHARGER IN LOW GEAR (LEVEL SPEEDS)
COMBAT RATING 2300 ENGINE RPM
HEIGHT FEET
BOOST PRESSURE ATA

Fig. 3A: Boost at level speeds. (Level speeds in Fig. 2A).

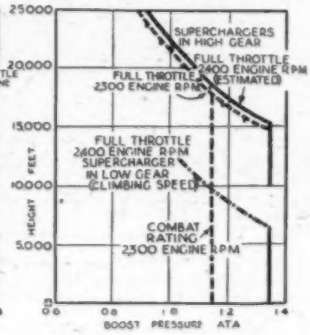

SUPERCHARGERS IN HIGH GEAR
FULL THROTTLE 2400 ENGINE RPM (ESTIMATED)
FULL THROTTLE 2300 ENGINE RPM
FULL THROTTLE 2400 ENGINE RPM SUPERCHARGER IN LOW GEAR CLIMBING SPEED
COMBAT RATING 2300 ENGINE RPM
HEIGHT FEET
BOOST PRESSURE ATA

Fig. 3B: Boost at climbing speeds. (Rate of climb and speeds in Fig. 2B).

Estimates of the speed at other throttle settings can be made, using the curve of variation of power with boost given in Fig. 1B. This curve was obtained from bench tests on Jumo 211D engines. The same variation is considered to apply to the Jumo 211G engines.

Partial Climb Tests

With the external bomb racks off and the wing petrol tanks full (total weight, 21,800 lb.), partial climbs were done at "combat" rating, superchargers in low gear at 6,000ft. The maximum rate of climb was 1,370ft./min. at 130 m.p.h. I.A.S. (see Fig. 4). The engine cowling gills were set one-third open (to avoid overheating of the engines).

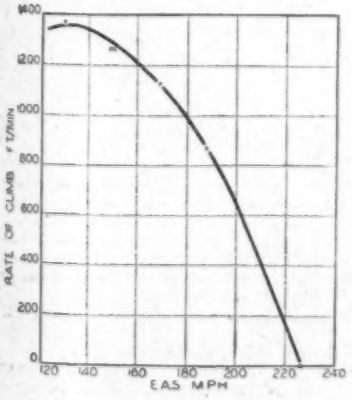


Fig. 4: Partial climbs of Ju 88 A-6 at 6,000ft. No external bomb racks; 21,800 lb.; boost pressure 1.15 ata; engine r.p.m. 2,300 (combat rating).

With the external bomb racks on (no bombs) and the wing petrol tanks full (total weight 22,200 lb.), a ceiling climb was done from 15,000ft. at full throttle and 2,300 engine r.p.m. On the strength of the partial-climb results, the climb was done at 130 m.p.h. I.A.S. up to 20,000ft., at 125 m.p.h. from 20,000ft. to 23,000ft., and thereafter at 120 m.p.h. To avoid overheating of the engines, the cowling gills were set two-thirds open up to 23,000ft. and then one-third open.

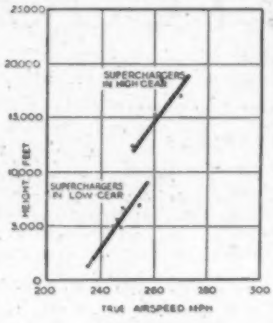


Fig. 5A: Level speeds at 1.15 ata boost pressure; engine r.p.m. 2,300 (combat rating). External bomb racks off; weight 19,870 lb.

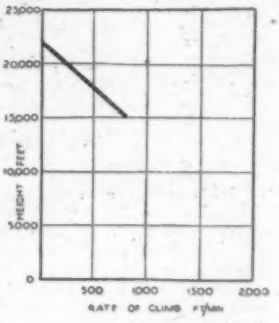


Fig. 5B: Estimated rates of climb with external bombs (four 250 kg.); full throttle; engine r.p.m. 2,400; superchargers in high gear.

The service ceiling (100ft./min.) at this loading, at full throttle, 2,300 engine r.p.m., and rich mixture, is 26,000ft. At 2,400 r.p.m. it can be estimated, from engine power considerations, that the service ceiling would be increased to 26,700ft.

From the speed measurements an idea can be obtained of the bomb drag, and it is estimated that the effect of fitting the four external 250 kg. bombs, thereby increasing the weight to 24,350 lb. and increasing the drag, would be to reduce the service ceiling to 21,000ft. (Fig. 5B).

Take-offs were done with four 250 kg. bombs carried externally and the wing tanks full (weight, 24,350 lb.).

The photographic and the plane table methods of measuring the take-off run were used. Two take-off runs were done, and the results obtained are given in the following table. The measured distances and the distances corrected to zero wind and to standard atmospheric conditions are given. The wind speed was 2.8ft./sec. on Run 1, and 3.3ft./sec. on Run 2. The ground temperature was 20 deg. C., and altimeter reading on the ground was 550ft.

	Distance Start to Take-off. Yards				Distance Start to 50ft. Yards		Corrected True Speed at T.O. m.p.h.
	Uncorrected		Corrected		Camera		
	Plane Table	Camera	Plane Table	Camera	Uncorrected	Corrected	
Run 1 ...	680	646	640	600	954	895	99.5
Run 2 ...	820	763	785	740	1,230	1,170	110.0

The difference in the take-off distances can be attributed to piloting technique.

A flowmeter is a standard fitting on the Ju 88 A-6, and some readings were taken. These are of some interest, and are presented here; too much importance must not, however, be attached to them, as no calibrations were made. The following table gives the indicated consumption rate:

Boost Pressure	Engine r.p.m.	Mixture	Petrol Consumption (Each Engine) Gals./Hour	Petrol Consumption from German Handbook (Each Engine) Gals./Hour
Ata 1.10 cruising ...	2,100	Weak	55	57
Ata 1.15 (Combat)...	2,300	Rich	65	66
Ata 1.35, full throttle	2,400	Rich	78	—

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

CABLE CUTTERS

British versus German Types

WITH reference to the article and pictorial comparison between the British and German methods of cable-cutting which appeared in *Flight* of January 8th, I quite fail to see from the illustration how the British cutter system functions satisfactorily.

Granted, in the event of one of the extremely "neat cutters" striking the cable, it will be rendered useless, but using the "Manchester" as an example, if either the forward gun turret, the engines, or even one of the many unprotected parts of the leading-edge strikes the cable, the position of the airscrew would not be very enviable.

Without wishing to be accused of being a member of that tiresome section of the population which wrongly imagines the Nazis have a monopoly where clever implements of war are concerned, I would like to finish by saying that, despite the German "fender" invention looking cumbersome and somewhat "Heath Robinson," it appears to be the more practical of the two.

B. J. W. SHERWOOD.

CAMERA CURIOSITY

A Press Photographer's Version

AS a Press photographer I was interested to read in your January 22nd issue R. H. Warring's letter on the part the camera shutter plays in producing freak representations of aircraft propellers in motion. In looking to the slit in his focal-plane shutter for the cause of these "distorted propellers," Mr. Warring is on the right track—but he errs when he theorises that one portion of the plate or film is exposed longer than another.

In practically every focal-plane shutter, what happens is briefly this: (*a*) The shutter is wound and set, causing the blind to traverse the plate *with slit closed;* (*b*) the shutter is fired; the blind flies back across the plate, but this time having its narrow slit open—which exposes the plate to the image from side to side, or from top to bottom.

The speed of the slit across the plate should be, in a good camera, to all intents and purposes constant, otherwise visibly uneven exposure of the plate would result. Therefore, variation in shutter speed at different points on the plate is not the cause of serious distortion. This is due mainly to the enormous speed of the revolving propeller. It is obvious that in a focal-plane camera (*i.e.*, one with a shutter such as has been described, operating immediately in front of the film or plate) one side of the plate will be exposed a split second earlier than the opposite side. In other words, one tip of a propeller is apt to be exposed a fraction of a second earlier in the revolution than the opposite tip, which has travelled to a new position by the time it, in turn, is exposed on the plate. The slower the shutter exposure the more exaggerated the distortion, up to a point where the shutter is so slow that the propeller has time to make several complete revolutions and is portrayed as a circular blur. If an ultra-fast exposure is made a head-on revolving propeller will be pictured almost straight, just like a stationary one, the motion being "frozen" by the camera.

Between-lens shutters operate differently and are not subject to the same distorting characteristics, but they have their own limitations.

Distortion caused by the moving slit is deliberately made use of by Press photographers to get dramatic effect. For instance, a racing car photographed through a slit moving in the *same* direction as the car's image in the camera appears elongated, with elliptical wheels which seem to be leaping forward (one side of wheels exposed before the other). If the slit moves in the *opposite* direction, the car's wheels will be raked backwards—looking as if the brakes have suddenly been jammed on.

For normal photography, in which horizontal movement is far commoner than vertical movement, a top-to-bottom shutter or vice versa will give negligible distortion at fast speeds, whereas a shutter moving side-to-side may give appreciable elongation or compression, according to which way up the camera is held.

JOHN ROOKE.

IDEAL FIGHTER

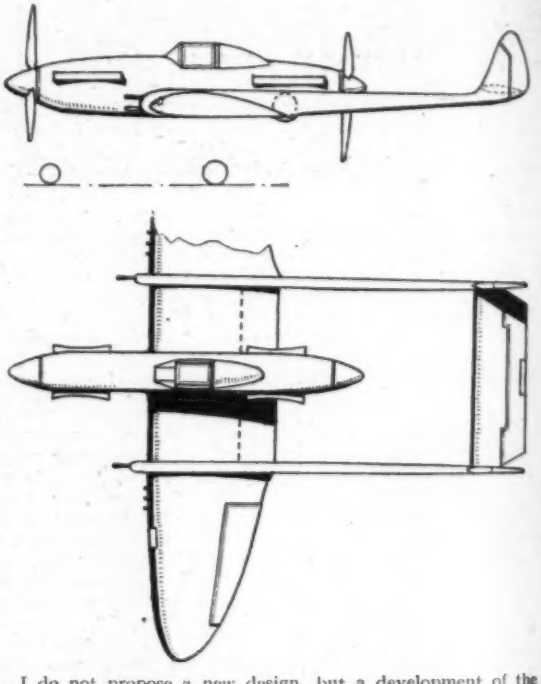
Tandem Engines with Tail Booms

I WOULD offer the following criticisms of the fighter designs with central airscrews and engines behind the pilot, which have recently appeared in your Correspondence pages:—

(1) Great complication of propeller gear, through which all tail stresses must be taken and tail controls pass.
(2) Vulnerability of this area to damage from tail attack.
(3) All air intakes are out of the slipstream.
(4) Exposed position of the pilot.
(5) Danger in baling out.

I consider (4) and (5) to be very important from the point of view of morale. As the pilot is now heavily armoured, even to the odd-square foot of windscreen, armour obviously matters. Also, in the event of a belly landing or nose over, the nose might cave in.

Once aboard, the pilot would surely be uncomfortable, knowing that baling out and any forced landing (with the prospect of meeting hedges or ditches) were both very dangerous. In battle, facing a bomber's tail armament, he would feel very "naked."



I do not propose a new design, but a development of the Fokker single-seater with the pilot between the engines and the tail on twin booms. Two engines of Merlin size giving 1,500 h.p.—perhaps they exist to-day—could be used. The weight distribution would be quite good and wetted area not greatly increased. Although I have not solved the problem of stepping out, I offer the following advantages:—

(1) Little development required—all components available to-day.
(2) Ability to fly and even fight on one engine.
(3) Tail booms available for undercart and main armament stowage, leaving the centre section free for ducted radiators and fuel stowage.

Disadvantages:—

(1) No improvement of view.
(2) Possibility of extensive plumbing.

2/LT., R.A.

Service Aviation

MARTIN MARAUDER (B.26) : This is one of the standard bombers to be mass produced in America for use by all the Allied Powers. It is a mid-wing all-metal monoplane with monocoque fuselage. The engines are two Pratt and Whitney 18-cylinder radials of 1,850 h.p. each, and these drive fully-feathering Curtiss electric airscrews of the latest four-bladed type. A tricycle undercarriage is fitted

Royal Air Force and Fleet Air Arm News and Announcements

A.T.C. Director

THE Secretary of State for Air has appointed T. W. W. Wakefield, M.P., to succeed J. F. Wolfenden, C.B.E., the headmaster of Uppingham, as Director of the Air Training Corps.

W. W. Wakefield is best known as an outstanding athlete. He was in the England Rugby XV from 1919 to 1927 and captained it from 1923 to 1927. He holds the record number of English caps. From 1919 to 1923 he was captain and secretary of the R.A.F. Rugby Football Club, and led the R.A.F. team in winning the Inter-Service matches. He captained Cambridge University R.F.C. in 1922, and subsequently captained Middlesex, Harlequins, and other famous Rugby football clubs for several years. In 1920 he won the R.A.F. quarter-mile championship and was a member of the Herne Hill Harriers running team. He is a playing member of the M.C.C. and other well-known cricket clubs, and a member of the British Ski Club.

THE KING has been graciously pleased to approve the following awards in recognition of gallantry and devotion to duty in the execution of air operations :—

DISTINGUISHED SERVICE ORDER.

Flt. Lt. C. L. Roy, No 150 Squadron.—Flt. Lt Roy has carried out his attacks with consistent skill and courage. He has set an example of admirable, cool judgment and determination, frequently in the face of strong enemy opposition, and he has been an inspiration to the rest of the squadron. As a captain Flt. Lt Roy has contributed much to the squadron's repeated successes, maintaining morale at a very high level. His operational sorties as captain have included six raids on Cologne and five on Hamburg.

BAR TO DISTINGUISHED FLYING CROSS.

Act. Sqn. Ldr. L. H. Day, D.F.C., No. 58 Squadron.—As a captain of aircraft, Sqn. Ldr. Day has always shown courage and devotion to duty. One night in July, 1941 he was detailed to carry out a mine-laying operation off the entrance to Benghazi Harbour. Gliding down to within 600 feet of the sea level and within 400 yards of the harbour mole, which he knew to be heavily defended, Sqn. Ldr. Day released his mines in the area detailed and flew off without being detected. The whole operation showed forethought and skill in execution, especially as this officer had not previously undertaken an operation of this type.

W/O N. L. Tayler, of No. 7 Squadron, standing by his Stirling. He was awarded the D.F.C. for his part in a daylight raid on Brest.

DISTINGUISHED FLYING CROSS.

Wing Cdr. B. K. BURNETT, A.F.C., No. 51 Squadron.—Wing Cdr. Burnett has commanded 51 Squadron with outstanding success for the past six months, and has taken an active share in operations against the enemy. His example and courageous leadership have been an inspiration to all. He has participated in four raids on Kiel.

Sqn. Ldr. R. G. M. WALKER.—This officer has carried out many successful operational flights, and has shown a very high degree of skill, combined with courage and determination.

Act. Sqn. Ldr. J. ALEXANDER, A.A.F., No. 37 Squadron.—This officer has participated in many long distance operations in which various targets have been attacked in France, Cyrenaica, Greece, Crete and the Dodecanese. Throughout, he has displayed great devotion to duty, and he has invariably been among the first to volunteer for any operation involving more than the normal risk. One night in October, 1941, Sqn. Ldr. Alexander carried out a most successful bombing attack on Berka airdrome, almost certainly destroying an ammunition dump; he also machine-gunned mechanical transport in the vicinity from a very low level. This officer has consistently set a fine example to all.

Act. Sqn. Ldr. G. R. COLENSO, No. 101 Squadron.—This officer's many sorties include a daylight attack on Brest in July, 1941, when he returned safely despite much opposition from hostile fighters. He is now on his second tour of operations, and has proved himself to be a very capable flight commander whose courage and devotion to duty are of the highest order. Sqn. Ldr. Colenso has set an excellent example in pressing home his numerous attacks under difficult conditions. He has acted as pilot in raids on many of the Channel ports and on industrial targets in Germany.

Act. Sqn. Ldr. A. G. S. COUSENS.—Three of Sqn. Ldr. Cousens' flights were to Berlin, and when returning from one of these operations one night in February, 1940, fog compelled him to abandon the aircraft by parachute. In so doing he broke his ankle. Since he was selected in June, 1941 as group navigation officer, he has set an admirable example by taking every opportunity to engage in night operations. His skill as a navigator and total disregard for his own

SERVICE AVIATION

safety have been quite outstanding. His flights have been mostly against heavily defended targets in Germany.

Act. Sqn. Ldr. W. S. HILLARY, D.F.M., No. 76 Squadron.—Sqn. Ldr. Hillary is a captain of aircraft and a flight commander of outstanding courage and ability. He has been operating continuously since war began, and has never shown signs of tiredness or waning enthusiasm. He is always eager for any job he undertakes, and never leaves it until it is successfully completed. When returning from Hanover on one occasion, the port inner engine of Sqn. Ldr. Hillary's aircraft failed completely when over the Dutch coast. He remained unperturbed, set course for the Norfolk coast, and landed safely on three engines.

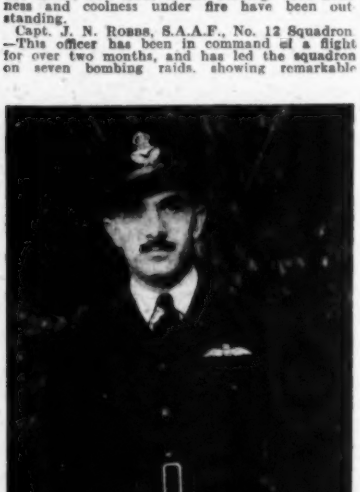
Act. Sqn. Ldr. M. T. STEPHENS, R.A.F.V.R., No. 3 Group Training Flight.—This officer, who commands a training flight, has inspired the large number of air gunners in training by his personal example and leadership. Although not called upon to continue operational flying, he has participated in nine operational sorties with units in the command to which his trainees have been posted. The initiative which Sqn. Ldr. Stephens has shown in this way has had a beneficial effect upon the gunnery in every unit. By his keenness and devotion to duty he has raised the morale and standard of the air gunners to a high level.

Flt. Lt. R. J. HARDIMAN, No. 208 Squadron.—This officer has carried out over 50 tactical reconnaissances in Hurricane and Lysander aircraft over Egypt, Libya and Greece, involving more than 100 hours' flying. He has shown admirable courage and determination in the completion of his tasks.

Capt. O. G. DAVIES, S.A.A.F., No. 12 Squadron.—This officer has been continuously engaged on operational flying during the past 11 months. Latterly he has commanded a section of Glenn Martin aircraft employed directly under Air Headquarters, East Africa. During reconnaissances, Capt. Davies has many times been intercepted by enemy fighters, which he has attacked when favourably situated, or skilfully evaded when the occasion warranted it. He has shown a fine spirit and has often descended to low level to machine-gun suitable targets observed during reconnaissance.

Capt. S. P. PALMER, S.A.A.F., No. 16 Squadron.—This officer has at all times shown the greatest devotion to duty. He has participated in numerous operational missions, and on 20 occasions has led the flight with much success. His photographic mosaic of the Omo River Valley was of the greatest assistance to the Army. On one occasion the rudder controls of his aircraft were shot away by anti-aircraft fire, but Capt. Palmer flew back to base, a distance of over 100 miles, and made a safe landing. His keenness and coolness under fire have been outstanding.

Capt. J. N. ROBBS, S.A.A.F., No. 12 Squadron.—This officer has been in command of a flight for over two months, and has led the squadron on seven bombing raids, showing remarkable



P/O G. V. Syer, who has had the distinction of being the first Empire Training Scheme pilot to fly a bomber across the Atlantic as a means of bringing both the machine and himself to the scene of operations.

The new Vultee Vengeance dive bomber which is being produced in the U.S.A. for the Royal Air Force. It looks to be quite equal to the Ju 87——and then some.

leadership and courage. On one occasion in October, 1941, when his formation of nine Maryland aircraft were intercepted by four Messerschmitt 109's, Capt. Robbs coolly and skilfully kept the formation together and covered one of the Marylands which was severely damaged and both its gunners wounded. One of the attackers was shot down in flames and another probably seriously damaged. The engagement terminated abruptly, leaving the squadron intact although the damaged Maryland was forced to land some ten minutes later, but well on our side of the lines.

Act. Flt. Lt. G. L. CAMPBELL, R.A.F.V.R., No 272 Squadron.—This officer has completed many hours' operational flying, involving patrols over Norway, France, the North Atlantic and the Mediterranean. He has destroyed at least two hostile aircraft in the air and probably destroyed others on the ground in low level attacks on enemy bases. Throughout, Flt. Lt. Campbell has set an excellent example.

Act. Flt. Lt. A. E. C. DERRETT, R.A.F.V.R., No. 150. Squadron—This officer's skilful navigation enabled his captain to lead his squadron formation in a daylight attack on Brest at the scheduled time. His coolness in the face of anti-aircraft fire resulted in his bombs straddling the target. In a recent night attack on Mannheim, in adverse weather, his skill enabled the target to be located. He made five runs over it in order to ensure that his bombs straddled the objective. Flt. Lt. Derrett's splendid record and cheerful efficiency, both on the ground and in the air, has earned for him the confidence and admiration of his squadron. He has shown untiring devotion to duty.

Act. Flt. Lt. J. L. GROVES, No. 112 Squadron.—This officer has been actively engaged on operations for the past fifteen months. Both as a section leader and latterly as a flight commander he has proved an asset to the squadron. On his last encounter with the enemy, whilst leading the squadron, Act. Flt. Lt. Groves shot down two enemy aircraft. Throughout, this officer has displayed a fine fighting spirit and exceptional keenness. He has destroyed six hostile aircraft, three of which were shot down during the campaign in Greece.

F/O K. E. SPENCE, No. 144 Squadron.—This wireless operator-air gunner has had to work his set in most adverse weather, and often it has been due to his skill that the aircraft has been navigated safely to base. In a daylight attack on Brest his aircraft was severely damaged in a continuous engagement with enemy fighters. He continued to use his guns with skill and determination, earning the praise of his flight commander, who was leader of the formation.

F/O. P. D. THOMPSON, R.A.F.V.R., No. 185 Squadron.—This officer has been continuously engaged on operational flying for the past twelve months. He has destroyed at least six enemy aircraft, three of which he shot down in the Battle of Britain. F/O. Thompson has set an excellent example of keenness, efficiency and skill.

F/O. W. L. WATSON, R.A.F.V.R., No. 148 Squadron.—This officer has carried out bombing missions over Germany and the Channel Ports, and over Italian territory.

Lt. A. R. INGLE, S.A.A.F., No. 12 Squadron.—During a raid on Yavello, Abyssinia this officer's aircraft was forced to land in the desert. Lt. Ingle and two other members of the crew were rescued ten days later, having been on foot throughout the period and unable to obtain water. Lt. Ingle is a most skilful bomb aimer and has at all times shown great keenness and devotion to duty.

Act. F/O. C. E. DINGLE, R.C.A.F., No. 144 Squadron.—This officer has engaged in a great number of sorties under adverse weather conditions, and his skill as a navigator has been instrumental in the safe return of his aircraft to base. His courage and personality have had a most inspiring effect upon all those who have served with him. He has taken part in attacks on enemy warships at Brest and in raids on many industrial targets in Germany.

P/O. J. J. ALLEN, R.A.F.V.R., No. 103 Squadron.—P/O. Allen has shown dogged determination, skill and devotion to duty. Fearlessly and with a fine offensive spirit, he sets his mind to the task, and shows a magnificent example to his crew. His resource and skill have enabled him to complete a very large number of operational flights, among which have been three raids on Mannheim, two on Dusseldorf and a long-distance attack on Turin.

P/O. H. BAKER, No. 144 Squadron.—P/O. Baker, who is now on his second operational tour, has been selected on many occasions to engage in most difficult tasks, all of which he has accomplished with great success. He is a most efficient officer, who has shown gallantry and devotion to duty during many raids into enemy territory, setting a high standard for the squadron.

P/O. H. R. BLAKE, R.N.Z.A.F., No 150 Squadron.—P/O. Blake is a keen and determined officer, who shows no fear. He has been an inspiration to his crew and to the squadron. On one occasion his aircraft was hit by flak when over the Ruhr, which damaged the ailerons and made the aircraft very difficult to control laterally. After losing considerable height, by great skill he regained control, and brought the aircraft safely back.

P/O. J. F. CRAIG, R.N.Z.A.F., No. 144 Squadron.—In November, 1941, when pilot of an aircraft engaged in a raid on shipping off the Frisian Islands, he attacked a 10,000-ton ship in a convoy from 50 feet and set it on fire. Later information confirmed that the ship was sunk. With utter disregard of his personal safety, P/O. Craig has never hesitated to attack from a low altitude when he has had difficulty in identifying the target. He is a particularly bold and keen bomber and his courage and skill have been an inspiration to all who have served with him.

P/O. A. P. DOWSE, No. 144 Squadron.—This officer has always reduced height when finding it difficult to identify the target. He has displayed great courage and determination, and has invariably completed successfully the tasks allotted to him.

P/O. B. GOODALE, R.A.F.V.R., No. 51 Squadron.—P/O. Goodale is a skilful and conscientious wireless operator, and has taken part in many of the longest and most difficult raids undertaken by the squadron. He has shown qualities of courage and devotion to duty which are equal to the highest standards. He has participated in three raids on Kiel and three on Berlin.

P/O. B. G. HADLAND, R.A.F.V.R., No. 106 Squadron.—P/O. Hadland on one occasion flying between 1,500 and 2,000 feet, bombed and machine-gunned the searchlights in a searchlight belt for 35 minutes. When over Holland one night in June, 1941, his aircraft was severely damaged in combat with an enemy fighter. Though forced to abandon the task of bombing Bremen, he landed the badly damaged aircraft at base without further mishap. As captain, he has attacked with good results most of the important enemy targets, including Berlin.

P/O. A. J. HEYWORTH, R.A.F.V.R., No. 12 Squadron.—In the daylight attack on Brest in July, 1941, P/O. Heyworth was engaged by an enemy aircraft after bombing the target. Disregarding his personal safety, he coolly directed defensive fire from the astro dome, and the enemy fighter was probably destroyed.

On another occasion, after a night bombing operation, he made a return flight of five hours on one engine. For this fine achievement he received recognition from the A.O.C.-in-C. in an Administrative Order. He has shown himself to be a skilful pilot and an able leader, and his consistent endurance has at all times set a high example to other members of the squadron.

SERVICE AVIATION

P/O. I. D. N. LAWSON, R.A.F.V.R., No. 148 Squadron.—This officer has been engaged on operational flying since November, 1940. Whilst serving in England, P/O. Lawson participated in sorties over Germany and German occupied territory. Since joining his present unit P/O. Lawson has been operating at high pressure against enemy targets in the Middle East, including 21 flights over Benghazi, often with new and inexperienced crews. Throughout, this officer has shown the greatest determination to bomb his target accurately, while his skill not only as a pilot but as an engineer has been outstanding.

BAR TO DISTINGUISHED FLYING MEDAL.

Flt. Sgt. D. A. HAMMATT, D.F.M., No. 106 Squadron.—Flt. Sgt. Hammatt has taken part in attacks on Hamburg, Bremen, Kiel, Cologne, Berlin and Brest and has not once had a wireless failure. His technical ability, cool courage and quiet efficiency have been an inspiration to the squadron.

Flt. Sgt. H. I. POPAY, D.F.M., No. 106 Squadron.—This airman is a wireless operator-air gunner of exceptional ability and has displayed great qualities of technical skill and reliability. He has taken part in attacks on Cologne, Kiel, Hamburg, Mannheim, Berlin, and in a daylight raid on Brest. His record has had an excellent effect on the whole squadron.

DISTINGUISHED FLYING MEDAL.

Flt. Sgt. L. R. C. GILBERT, No. 76 Squadron.—This airman has been employed as an air gunner on operations against the enemy since the beginning of the war and has carried out many sorties against enemy and enemy occupied territory. On several occasions he has encountered enemy night fighters and, one night in October, 1940, he was wounded during an encounter with five Messerschmitt 109s. Flt. Sgt. Gilbert has also proved invaluable in assisting in the training of air gunners, a duty in which he has displayed keenness and discretion. He has set a fine example to all by his gallantry and devotion to duty.

Flt. Sgt. S. H. HIPKIN, S.A.A.F., No. 12 Squadron.—Flt. Sgt. Hipkin has participated in many operational flights, as an air gunner. He has been attacked by enemy fighters on 15 occasions and has destroyed two Fiat C.R.42.

Temp. Flt. Sgt. A. J. K. MOON, No. 44 (Rhodesia) Squadron.—This airman has participated in a large number of sorties over enemy territory, including attacks on all the more important industrial targets and dockyards in Germany. He has acted as first wireless operator on 45 occasions, including one flight of 12 hours' duration in adverse weather. Throughout, Flt. Sgt. Moon has displayed great courage and efficiency which have been mainly responsible for the safe return of his aircraft on several occasions.

Flt. Sgt. J. G. ROBERTS, R.A.F.V.R., No. 106. Squadron.—Flt. Sgt. Roberts made his first seven operational sorties as navigator and the remainder as captain of aircraft. His sorties have all been carried out against the more heavily defended enemy targets. Throughout Flt. Sgt. Roberts has displayed outstanding ability.

Sgt. (now P/O.) R. N. ALLEN, R.N.Z.A.F., No. 75 (N.Z.) Squadron.—As a captain of aircraft, this airman has taken part in attacks on Cologne, Hamm, Munster, Bremen, Kiel, Hamburg and Brest with the utmost determination and efficiency. He has consistently carried out all his operations with the greatest courage and determination, and his keenness and enthusiasm have been a source of inspiration to all. He volunteered for operations in the Middle East when his term of duty in No. 75 Squadron was completed and was bitterly disappointed when his posting was cancelled.

Sgt. J. G. BRUCE, No. 105 Squadron.
Sgt. A. H. FLETT, No. 105 Squadron.

These airmen have taken part as pilot and observer respectively in many low level attacks by day on shipping and on heavily defended objectives on land. On July 4th, 1941, when taking part in a low level attack on Bremen in daylight, the aircraft returned with a piece of telephone wire on its tail wheel and the tail plane was badly damaged by cannon fire. On July 16th, 1941, during a daylight raid on Rotterdam, Sgt. Flett obtained direct hits on a 6,000-ton ship and on some barges, his aircraft being again hit by enemy fire. These airmen have shown magnificent courage and devotion to duty and a high degree of skill in their respective duties.

Sgt. A. CAMERON, No. 12 Squadron.—As captain of aircraft, this airman has participated in many attacks on enemy and enemy occupied territory with consistent skill and courage. On one occasion he was attacked by an enemy aircraft while preparing to land at his base. Although his aircraft was flying very low and one engine was put out of action, Sgt. Cameron succeeded in evading further attacks and landed safely.

On another occasion he carried out a 300 miles sea crossing with one engine out of action, and in conditions of very poor visibility made a crash landing at his base with a minimum damage to his aircraft. His cool judgment and determination have proved to be an inspiration to all.

Sgt. W. H. CAPPLEMAN, No. 150 Squadron.—This airman has taken part, as a pilot in attacks on Duisberg, Kiel, Cologne, Hamburg, Bremen, Dunkirk, St. Nazaire, Lorient and Brest. He has consistently shown skill and cool judgment while pressing home his attacks, frequently in the face of strong enemy opposition. He has set a magnificent example by his cheerful courage, unselfishness and great devotion to duty.

ROOF WATCHING : An air gunner keeps watch in a gun blister of a Coastal Command Catalina during patrol. The guns are twin Vickers Ks.

Sgt. A. CAESAR-GORDON, No. 144 Squadron.—Sgt. Caesar-Gordon has completed his operational tour with a high degree of success. The majority of his flights have been carried out in adverse weather, but he has frequently shown great skill as pilot in flying his aircraft back to base. He has always been ready to volunteer for the most difficult and dangerous tasks, thus setting an excellent example.

Sgt. W. J. DALTON, R.A.F.V.R., No. 70 Squadron.—This airman is a most reliable and experienced captain who always reaches his target and attacks with determination. On a recent occasion over Benghazi, despite intense anti-aircraft fire and searchlight activity, he made several runs over the area, and finally succeeded in scoring three direct hits with bombs which caused a fire on the Mole. By his coolness and courage in the face of enemy fire and his willingness to undertake any task, this airman has set a splendid example.

Sgt. M. E. H. DAWSON, R.A.F.V.R., No. 76 Squadron.—As an observer, this airman has taken part in many attacks on enemy territory with great keenness and devotion to duty. On many occasions his aircraft has been damaged by anti-aircraft fire, or by enemy fighters, in particular during a daylight raid on La Pallice when most of the instrument panel and windscreen were shot away and the rear gunner was wounded. Sgt. Dawson's perseverance in locating the target is exemplary, and in spite of many trying experiences he has displayed great cheerfulness, keenness and courage.

Sgt. F. DENTON, No. 76 Squadron.—This airman carried out 90 sorties with Coastal Command on daylight operations over the sea. He has since completed 10 night sorties as air gunner with No. 76 Squadron, which have included attacks on Hamburg, Hanover, Mannheim, Berlin and Turin. He has set an excellent example by his keenness and devotion to duty.

Sgt. H. R. EDGE, No. 150 Squadron.—As an observer, this airman has participated in sorties over Germany and Occupied France. He has shown great courage in the face of enemy opposition and his coolness and devotion to duty have largely contributed to the success achieved. He has taken part in four raids on Kiel and three on Cologne.

Sgt. F. L. FEWKES, A.A.F., No. 76 Squadron.—As a wireless operator-air gunner, this airman has taken part in attacks on Wilhelmshaven, Bremen, Hamburg, Cologne, Kiel, Berlin, Ostend, Brest, Cherbourg and Turin. Sgt. Fewkes's skill and perseverance have greatly contributed to the successes achieved in spite of hazardous experiences caused by severe electrical storms, damage by anti-aircraft fire and engine failure. This airman's keenness and courage have set an excellent example.

Sgt. D. S. FISHER, R.C.A.F., No. 103 Squadron.—This airman has successfully navigated his aircraft on many long operational flights and he has shown a complete disregard for his personal safety in the face of enemy opposition. He has participated in attacks on Brest, Cologne, Rotterdam, Kiel, Bremen, Berlin and Turin. Sgt. Fisher's tenacity, fine spirit and cheerful confidence have set a high standard.

Sgt. C. S. GEORGE, No. 10 Squadron.—This airman has carried out his duties as wireless operator/air gunner in an exemplary manner, and his efficiency has been largely instrumental in the successful conclusion of many of his operational missions. Targets attacked include Brest, Cologne, Bremen, Rotterdam, La Pallice and Hamburg. Sgt. George's keenness and cheerfulness have been an inspiration to less experienced operators.

Sgt. L. W. JONES, No. 97 Squadron (since killed).—One night in November, 1941, this airman was the rear gunner of an aircraft detailed to attack a target in the Rhineland. On the return journey Sgt. Jones saw a Messerschmitt 110 silhouetted in searchlights, approximately 1,000 feet below the aircraft. He withheld his fire until the enemy closed to within 50 yards and then shot it down. The enemy aircraft was seen to crash on the ground. During the many sorties Sgt. Jones has carried out against the enemy he has displayed great keenness and efficiency as a rear gunner.

Sgt. G. F. KEEN, No. 51 Squadron.—During the many sorties in which this wireless operator has participated, some of which have been at extreme range, he has displayed high qualities of courage and determination. His technical skill is of a high order and on one occasion, after a raid on Stuttgart, his steadiness in obtaining wireless aid was solely responsible for the safe return of his aircraft after bearings had been completely lost.

The new battle dress designed for the R.O.C. On the left breast is a circular badge bearing the words Royal Observer Corps with an eagle in the centre and surmounted by a crown.

SERVICE AVIATION

Sgt. E. R. LONG, R.C.A.F., No. 12 Squadron.—This airman has shown high and consistent ability as a wireless operator during many attacks on enemy territory, including four raids on Berlin. On one occasion when the starboard engine of his aircraft failed, Sgt. Long succeeded in maintaining two-way communication with base and obtained two vital W/T fixes, thus largely contributing to the safe return of the aircraft. His keenness and enthusiasm for operations have set a splendid example.

Sgt. P. R. MCLAREN, No. 51 Squadron.—As a wireless operator-air gunner, Sgt. McLaren has participated in many attacks on Germany, including Bremen, Cologne and Berlin. On several occasions his skill and steadiness have been largely responsible for the safe return of the aircraft to base and for the success of the sorties. Sgt. McLaren has displayed great courage and determination and has set an excellent example.

Sgt. E. H. MANTLE, No. 144 Squadron.—This airman has carried out his duties as wireless operator-air gunner most conscientiously and both in the air and on the ground his work has been of a high order. Sgt. Mantle has several times quickly repaired unserviceable wireless equipment during flight. His cheerfulness and determination when faced with enemy opposition have always been appreciated by the other members of the crew.

Sgt. R. MARTIN, No. 203 Squadron.—In October, 1941, this airman was engaged in combat with a Messerschmitt 110. Although his aircraft was repeatedly hit by the enemy's fire, Sgt. Martin kept his guns in action, exercising excellent fire control. Eventually, the enemy aircraft was probably destroyed. Throughout, this airman displayed great skill and coolness and undoubtedly contributed materially to the safe return of his aircraft.

Sgt. A. MORRIS, No. 144 Squadron.—This pilot has taken part in raids on many targets in Germany as well as in an attack on the German battle-cruisers at Brest. He never hesitates to fly low to locate his objective in bad weather. One night in October, 1941, he was captain of an aircraft which was badly damaged by anti-aircraft fire whilst on the outward journey to Frankfurt. In spite of this, Sgt. Morris carried out a successful attack on the target and returned to base under very difficult conditions. He has displayed continuous gallantry and devotion to duty.

Sgt. J. K. NAPIER, No. 51 Squadron.—This airman has at all times shown great keenness to participate in operations against the enemy. As first wireless operator-air gunner he has participated in attacks on Brest, Kiel, Lorient, Cologne, Bremen, and Hamburg. Sgt. Napier has displayed great skill and courage under the most trying conditions and has shown unfailing devotion to duty.

Sgt. R. G. PURNELL, No. 106 Squadron.—On all his sorties, Sgt. Purnell has acted as captain of aircraft. He has carried out raids on many vital targets, ranging from the naval ports in Germany and France to the industrial centres of the Ruhr. He has frequently spent long periods over the target waiting for favourable conditions to ensure an accurate attack. Sgt. Purnell has proved reliable and courageous in the performance of his operational tasks.

Sgt. F. SMITH, No. 150 Squadron.—This airman has carried out ten sorties as front gunner and twenty-two as first wireless operator, and has shown the most determined spirit. He has taken part in attacks on Boulogne, St. Nazaire, Cherbourg, Le Havre, Cologne, Kiel, Bremen, and Hamburg. Sgt. Smith's skill and initiative have largely contributed to the success of many sorties.

Sgt. F. A. TRICKLEBANK, No. 38 Squadron.—This airman has always displayed great skill and determination in pressing home his attacks, especially when flying low over Tripoli Harbour to ensure that new arrivals of enemy shipping were hit by bombs before their cargoes could be unloaded. One night in August, 1941, Sgt. Tricklebank bombed and hit a ship in Tripoli Harbour, despite strong opposition from the harbour defences. The ship caught fire and was completely destroyed.

THE KING has been graciously pleased to approve the following awards:—

GEORGE MEDAL.

Act. Cpl. T. HILL.—On August, 27th, 1941, at about 15.00 hours, an aircraft crashed through the roof into the main hall of the central railway station at Blackpool. On impact, a large explosion occurred and the aircraft burst into a mass of flames. The heat was terrific and the whole place became an inferno. Nevertheless, Cpl. Hill rushed into the fire and extricated a woman from the wreckage. He returned and got out a second woman who was under a girder. The clothes of both the women were burning and Cpl. Hill, assisted by a policeman, beat out the flames.

Large portions of the roof were now falling and pieces of wreckage were flying in all directions. Another woman could be heard screaming in the wreckage. Despite warning shouts that the roof was in danger of collapsing, Cpl. Hill covered his face with his arm, dashed into the flames again and succeeded in extricating her. Her clothes were also a mass of flames but Cpl. Hill took off his tunic and, assisted by two other persons beat out the flames. The woman was still alive but badly burned.

Cpl. Hill displayed undaunted courage throughout, and undoubtedly rescued the three persons at the risk of his own life.

L.A/C. S. W. J. GREEN.—One night in September, 1941, at 21.50 hours, an aircraft crashed on an aerodrome and immediately burst into flames. Ignoring the intense heat, exploding ammunition and oxygen bottles, L.A/C. Green, arriving on the scene, assisted in freeing the trapped gunner, a feat which was accomplished by smashing the rear turret with bare hands and breaking the guns from their brackets. With complete disregard for his own safety, L.A/C. Green, whose hands were burned in the process, worked heroically until the airman was saved. He set a very fine example.

Cpl. L. C. BRIDGEMAN.—A vessel which was taking a Naval and Royal Air Force salvage crew to salve an aircraft which had crashed into the sea on the previous day struck a mine and sank. After the explosion, however, the forepart of the vessel remained afloat for a short period, and Cpl. Bridgeman, accompanied by a naval officer, descended to the hold in an endeavour to rescue injured personnel.

Despite warning shouts, Cpl. Bridgeman continued his rescue work, and, when this portion of the vessel capsized and sank, he went under with the wreckage, but managed to get clear and was rescued later. The naval officer who was assisting him in his efforts to rescue the injured lost his life.

Although suffering from the effects of the explosion, Cpl. Bridgeman displayed great bravery in dangerous circumstances.

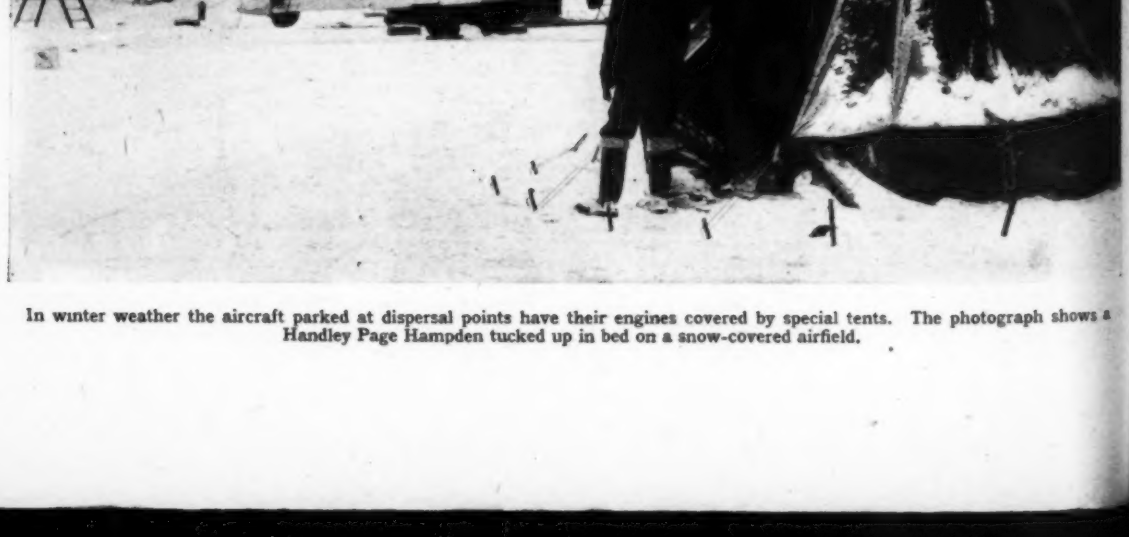
BRITISH EMPIRE MEDAL (MILITARY DIVISION).

Sgt. J. BREMNER.—In October, 1941, Sgt. Bremner was wireless operator in an aircraft engaged in exercises over the sea. When some 10 miles from the coast one engine failed. The pilot then turned the aircraft towards land after having released his bombs into the sea and, when endeavouring to make a forced landing, the aircraft crashed in a field and caught fire. Sgt. Bremner was stunned, but recovering quickly, immediately went to the assistance of the three other members of the crew who were completely incapacitated.

He succeeded in removing from the aircraft the second wireless operator and the navigator, both of whom were unconscious. He then attempted to extricate the pilot who was trapped in the cockpit, although, it is believed, he was already dead. Whilst so doing, Sgt. Bremner saw people in the distance, shouted for help, and then collapsed.

He had received concussion and shock as a result of the accident, and had not other help arrived when he collapsed, he and his comrades whom he had saved, might have been in further grave danger from exploding petrol tanks. This airman displayed great courage and initiative in dangerous circumstances and was undoubtedly the main factor in rescuing two of his comrades. Unfortunately one of them succumbed to his injuries the same night.

L.A/C. R. D. MOORE, R.A.A.F.—When an aircraft crashed into the sea in August, 1941, L.A/C. Moore, in company with other airmen and officers, entered the shark-infested sea in an endeavour to rescue the crew. Although others were forced to return to the beach because of the burning petrol and wreckage which hindered attempts at rescue, L.A/C. Moore, exercising marked determination, succeeded in reaching the main portion of the wreck. He carried on diving into the wreckage in repeated attempts to reach anyone who might have been trapped in the aircraft, and only ceased through extensive and severe petrol burns of the first degree to face and chest which necessitated immediate medical treatment. This airman displayed outstanding courage, determination and devotion to duty, as he was fully aware of the danger from sharks which infested these waters and the possibility of major injury from the burning petrol.



In winter weather the aircraft parked at dispersal points have their engines covered by special tents. The photograph shows a Handley Page Hampden tucked up in bed on a snow-covered airfield.

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